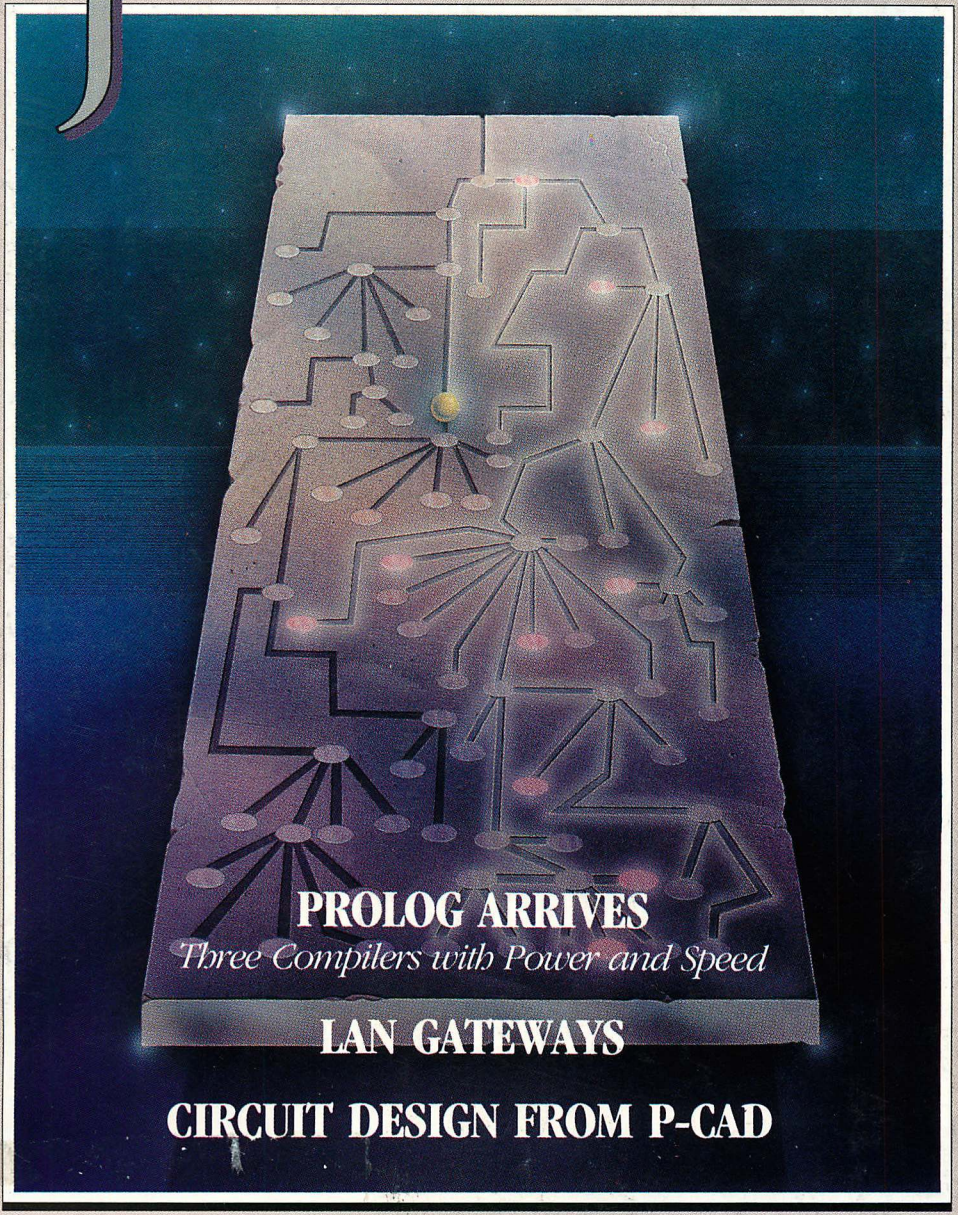
NOVEMBER 1986 VOL. 4 NO. 11 $3.95

FOR IBM PERSONAL COMPUTER USERS

PC TECH JOURNAL®



PROLOG ARRIVES

Three Compilers with Power and Speed

LAN GATEWAYS

CIRCUIT DESIGN FROM P-CAD

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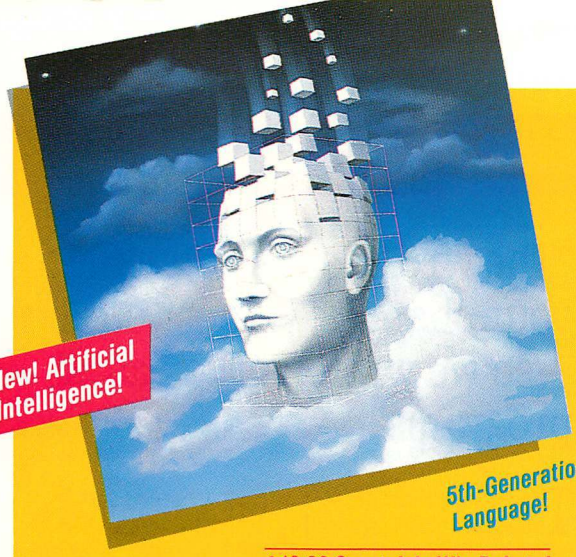
Turbo Pascal Programming



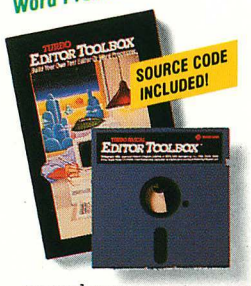
$10.00 Scratch 'n Win Rebate!

Turbo Prolog™

"If you're at all interested in artificial intelligence, databases, expert systems, or new ways of thinking about programming, by all means plunk down your $100 and buy a copy of Turbo Prolog."
Bruce Webster, BYTE

"Borland International, Inc. is gunning onto the fast track in the artificial intelligence and engineering-language-software race, riding aboard a new $99 Turbo Prolog," says Tom Schwartz in *Electronic Engineering Times.* And so we are. Our new Turbo Prolog has drawn rave reviews—which we think are well deserved—because Turbo Prolog brings 5th-generation language and supercomputer power to your IBM PC and compatibles. Turbo Prolog is a high-speed compiler for the artificial intelligence language, Prolog, which is probably one of the most powerful programming languages ever conceived. We made a worldwide impact with Turbo Pascal and you can expect the same results and revolution from Turbo Prolog, the natural language of artificial intelligence. Darryl Rubin, writing in *AI Expert* said, *"Turbo Prolog offers generally the fastest and most approachable implementation of Prolog."* Suggested retail, $99.95. Use a $10.00 Scratch 'n Win Rebate and that goes down to only *$89.95!* Minimum memory: 384K.

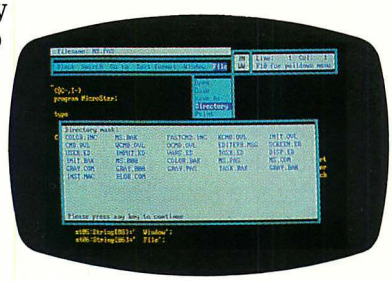
Build Your Own Word Processor!



$10.00 Scratch 'n Win Rebate!

Turbo Editor Toolbox™

Recently released, we called our new Turbo Editor Toolbox a "construction set to write your own word processor." Peter Feldmann of *PC Magazine* covered it pretty well with, *"A 'write your own word processor' program for intermediate level programmers, with lots of help in the form of prewritten procedures covering everything from word wrap to pull-down windows."* Source code is included, and we also include MicroStar, a full-blown text editor with pull-down menus and windowing. It interfaces directly with Turbo Lightning to let you spell-check your MicroStar files. Jerry Pournelle of *BYTE* magazine said, *"The new Turbo Editor Toolbox is the Turbo Pascal source code to just about anything you ever wanted a PC-compatible text editor to do."* Suggested retail: $69.95. Use a $10.00 Scratch 'n Win Rebate and you'll get all this for *only $59.95!* Minimum memory: 192K.



MicroStar file directory accessed by pull-down menu

Technical Specifications:

TURBO PASCAL 3.0 Minimum memory: 128K; includes 8087 and BCD features for 16-bit MS-DOS and CP/M-86 systems. CP/M-80 version minimum memory: 48K; 8087 and BCD features not available. ***TURBO DATABASE TOOLBOX*** Minimum memory: 128K. CP/M-80 minimum memory: 48K. Requires Turbo Pascal 2.0 or later. ***TURBO GRAPHIX TOOLBOX**** Minimum memory: 192K. Requires PC/MS-DOS 2.0 or later, Turbo Pascal 3.0, and IBM CGA, Hercules Monochrome Card or equivalent. ***TURBO TUTOR 2.0*** Minimum memory: 192K. CP/M-80 version minimum memory 48K. Requires PC/MS-DOS 2.0 or later and Turbo Pascal 3.0. ***TURBO EDITOR TOOLBOX**** Minimum memory: 192K. Requires PC/MS-DOS 2.0 or later and Turbo Pascal 3.0. ***TURBO GAMEWORKS**** Minimum memory: 192K. Requires PC/MS-DOS 2.0 or later and Turbo Pascal 3.0. ***TURBO PROLOG**** Minimum memory: 384K. ***REFLEX: THE ANALYST**** Minimum memory: 384K. Requires IBM CGA, Hercules Monochrome Card or equivalent. Works with Intel's AboveBoard-PC and -AT; AST's RAMpage! and RAMpage! AT; Quadram's Liberty-PC and -AT; Tecmar's 640 Plus; IBM's EGA and 3270/PC; AT&T's 6300 and many others. ***REFLEX WORKSHOP**** Minimum memory: 384K. Requires Reflex: The Analyst. ***TURBO LIGHTNING**** Minimum memory: 256K. Two disk drives required. Hard disk recommended. ***LIGHTNING WORD WIZARD**** Minimum memory: 256K. Requires Turbo Lightning. Turbo Pascal 3.0 required to edit source code. ***SIDEKICK**** Minimum memory: 128K. ***TRAVELING SIDEKICK**** Minimum memory: 256K. ***SUPERKEY**** Minimum memory: 128K. *For IBM PC, AT, XT, PCjr and true compatibles only, running PC/MS-DOS 2.0 or later.

Borland's Business Productivity Programs:

Reflex: The Analyst* Analytical database manager. Provides complete, new look at data normally hidden by programs like 1-2-3® and dBASE.® Best report generator for, and complement to, 1-2-3.

Reflex Workshop™ Important new addition to Reflex: The Analyst. Gives you 22 different templates to run your business right.

SideKick* Complete RAM-resident desktop management includes notepad, dialer, calculator and more.

Traveling SideKick* Electronic version of business/personal diaries, daytime organizers; works with your SideKick files; important professional tool.

SuperKey* Keyboard enhancer. Simple macros turn 1000 keystrokes into 1. Also encrypts your files to keep confidential files confidential.

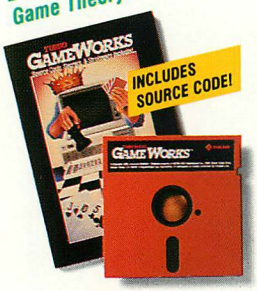
Borland's Electronic Reference Programs:

Turbo Lightning* Works with all your programs and checks your spelling *while you type*! Includes 80,000-word Random House® Concise Word List and 50,000-word Random House Thesaurus. Forerunner of Turbo Lightning Library.™

Lightning Word Wizard™ Includes ingenious crossword solver and six other word challenges. If you're into programming, Lightning Word Wizard is also a development toolbox and the technical reference manual for Turbo Lightning.

Turbo Pascal Programming

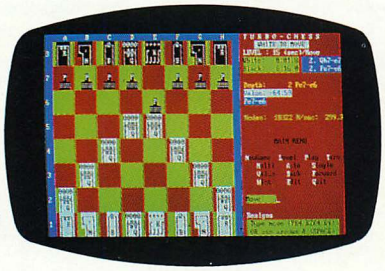
Learn Secrets, Strategies, Game Theory!



$10.00 Scratch 'n Win Rebate!

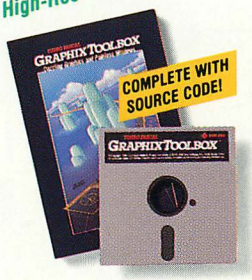
Turbo GameWorks®

Also recently released, Turbo GameWorks is what you think it is: "Games" and "Works." Games you can play right away (like Chess, Bridge and Go-Moku), plus the Works—which is how computer games work. All the secrets and strategies of game theory are there for you to learn. You can play the games "as is" or modify them any which way you want. Source code is included to let you do that, and whether you want to write your own games or simply play the off-the-shelf games, Turbo GameWorks will give hours of diversion, education, and intrigue. George Koltanowski, Dean of American Chess, and former President, United States Chess Federation, reacted to Turbo GameWorks like this: "*With Turbo GameWorks, you're on your way to becoming a master chess player.*" And Kit Woolsey, writer, author, and twice Champion of the Blue Ribbon Pairs, wrote, "*Now play the world's most popular card game—Bridge . . . even program your own bidding and scoring conventions.*" Suggested retail: $69.95. Use a $10.00 Scratch 'n Win Rebate and you're talking an *incredible $59.95!* Minimum memory: 192K.



Turbo GameWorks' Chessboard

Create Your Own High-Res Graphics!



$10.00 Scratch 'n Win Rebate!

Turbo Graphix Toolbox®

It includes a library of graphics routines for Turbo Pascal programs. Lets even beginning programmers create high-resolution graphics with an IBM, Hercules,™ or compatible graphics adapter. Our Turbo Graphix Toolbox includes all the tools you'll ever need for complex business graphics, easy windowing, and storing screen images to memory. It comes complete with source code, ready to compile. Suggested retail: $69.95, but with a $10.00 Scratch 'n Win Rebate, *only $59.95!* Minimum memory: 192K.

The Ultimate Learning Experience!

$10.00 Scratch 'n Win Rebate!

COMPLETELY NEW VERSION!

Turbo Tutor® 2.0

The new Turbo Tutor can take you from "What's a computer?" through complex data structures, assembly languages, trees, tips on writing long programs in Turbo Pascal, and a high level of expertise. Source code for everything is included. New split screens allow you to put source text in the bottom half of the screen and run the examples in the top half. There are quizzes that ask you, show you, tell you, teach you. You get a 400-page manual—which is not as daunting as it sounds, because unlike many software manuals, it was not written by orangutans. Suggested retail: $39.95. Use a $10.00 Scratch 'n Win Rebate and you're down to an *unheard of $29.95!* Minimum memory: 192K.

Recognition for Borland International has come from business, trade, and media, and includes both product awards and awards for technical excellence and marketing.

America's Cup. Coming Soon!

How to use Scratch 'n Win Rebates

It's really simple. You purchase the product between 9/5/86 and 3/31/87, and return the license agreement along with dated proof of purchase and your rebate card. We'll mail you a check for $10.00 on single product purchases or a check for $15.00 when you buy an advertised "bundle"—which means our Turbo Pascal Jumbo Pack, or Turbo Lightning and Lightning Word Wizard, or Reflex: The Analyst and Reflex Workshop, or SideKick and Traveling SideKick. (Restrictions do apply. See Official Rules on back of Instant Winner card).

Send a buck to the boat!

If you'd like to help America's effort to recapture the America's Cup from Australia, you can make a tax-deductible donation to "Heart of America" Challenge, 11 South LaSalle St., Suite 1670, Chicago, Illinois 60603

Sail designs generated from Shore Sails' Turbo Pascal programs.

How Borland is helping bring the America's Cup back to America!

"I think those who grasp the technology will prevail"

Bill Shore, President,
Shore Sails Co., Newport, RI

Borland's Philippe Kahn at the helm of America's Cup challenger "Heart of America," with Shore Sails' President Bill Shore

"Sail-making is traditional—a craft—but I think we're huge steps ahead of the competition when we get involved with higher technology," says Shore.

He and Shore Sails' 17 different franchised sail lofts in the U.S. are in what Shore describes as a "highly competitive business, whether it's America's Cup racing or any race." And he adds, "You guys (Borland) do good stuff that's affordable, which is one of the reasons why we wrote all our sail design programs in Turbo Pascal.®"

"These days," he says, "there are many parts to a sail, and Turbo Pascal lets us arrange all the parts properly. We design what the garment industry calls a 'marker'—and rely on Turbo Pascal to do critical things like getting thread lines in the same direction as load lines.

We take the diskette to our new $250,000 laser cutter, which follows the Pascal program precisely, draws out the sail and cuts out the sail. We glue and sew and you've got the best there is."

"Heart of America" sporting its new Borland spinnaker, surfing downwind, Santa Cruz, California

"The wrong sails will sink your chances—if not your boat—so we wrote Turbo Pascal programs"

Win Fowler, Shore Sails Co., Portland, Maine.

The right sail design, at the right price, right now, has to happen in 17 different Shore Sails Lofts across America.

It had to happen with America's Cup challenger *Heart of America* which carries Shore sails—and it has to happen with the (currently) 700 different boats that Shore Sails has in their Turbo Database Toolbox.™

Sail design, sail pricing and "beating the handicapper" are all done at Shore Sails with Turbo Pascal.

In case you don't know the sharp end from the blunt end of a boat, the right sail design for any boat is more than design and price. It's tactical advantage. Designing sails that take the greatest advantage of the boat's basic design and rigging without getting stuck with a heavier-than-desirable Official Handicap. (Handicaps can eat your chances faster than a Great White.)

The "right sail" design bends but doesn't break the racing rules written by, amongst others, MORC (Midget Offshore Racing Club) or IOR (International Offshore Rules). Turbo Pascal spills out "right sail" designs for Shore Sails so their customers tend to "handicap" the Rules Committee instead of the other way around.

Shore Sails' connection with Borland doesn't end with Turbo Pascal and our Database Toolbox.

Shore's Fowler has also written SuperKey® macros for "every file we have" and says, "We'd be lost without them."

He uses SideKick® to dial every phone call and SideKick's Notepad to communicate between all the Lofts, saying, "That way we don't need a word processor." Shore Sails also uses Turbo Lightning® and Reflex: The Analyst.®

So why so many Borland products in one company?

Win Fowler says, "We'd be sunk without them!"

"There is no second prize" Omar Bradley

Sail designs generated from Shore Sails' Turbo Pascal programs.

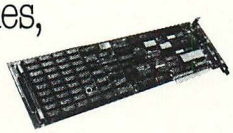
Borland's Instant Winner Game

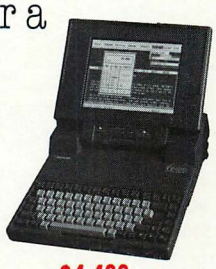
Scratch this card now and you could *instantly win* 2 free round-trip airline tickets to Australia for the America's Cup Race!

$10,000

First Prize ($10,000 value!) includes accommodations for two in Perth, Australia during the final America's Cup races, which start January 31, 1987. See America win it back after our *only* loss in 134 years! There's more than one *instant winner* in Borland's Instant Winner Game, because you could win one of two new $6,895 4-WD Suzuki Samurai convertibles, or a $4,995 AST TurboLaser™ printer, or a $4,499 Toshiba T3100,™ or a $2,399 Toshiba T1100™ Plus, or a $595 AST SixPakPremium™, or a $69.95 Traveling SideKick,® or any one of hundreds of other Borland products—and at the very least a Borland Rebate Coupon, good for $10 off any single product or $15 off any bundled product offer!

$6,895





$4,499

$69.95

See Official Rules on the back of this card for details.

Don't delay! There will be a second-chance drawing for the trip if not claimed by 12/30/86. There's also a second-chance drawing for the two Suzukis if not claimed by 2/26/87. All rebate coupons are good for products purchased 9/5/86-3/31/87. Product prices above are suggested list prices.

Rub the silver box to reveal whether you win a prize or get a rebate coupon. Then fill in the second-chance entry blank to the right.

Second-Chance Sweepstakes Entry!

We're running two Second-Chance Sweepstakes drawings to award the trip and cars. They *will be won* by someone—it *could be you!* Fill in the entry coupon and mail it now. Winners will be notified immediately, because the final America's Cup races start in Australia on January 31, 1987, and you'll have to pack in a hurry.

(You will need a valid passport and the ability to comprehend Australian versions of the English language.)

Name _____

Address _____

City _____

State _____ Zip _____

OFFICIAL RULES - BORLAND INSTANT WINNER GAME

1. NO PURCHASE NECESSARY: To participate, you may obtain a game card inserted into the October, November, December, or January issue of the following magazines: PC World; Byte; PC Tech Journal; PC Magazine. You may also obtain a game card by mailing a self-addressed, stamped envelope to: Borland International Game Card, P.O. Box 870, Wilton, CT 06897. (Washington State residents send self-addressed envelope.) Limit one game card per stamped request. All requests must be received by January 15, 1987.

2. TO PLAY: Remove the rub-off area on the game card to reveal what prize or rebate offer you have obtained.

3. PRIZES/REBATES: Beneath the rub-off area one of the following prizes may be revealed: Trip for Two to America's Cup Races or $10,000; 1986 Suzuki 4W Samurai Convertible or $6,895; AST Turbo Laser; Toshiba 1100 Portable Computer; Toshiba 3100 Portable Computer; AST Sixpakpremium; AST Advantagepremium; AST 3G Pak; AST Rampage; AST Rampage AT; Free Borland Product, or you may obtain the following rebate offer: $10 rebate offer on any individual product or $15 rebate offer on any single advertised Borland bundle (See rule #11 for prize details.).

4. PRIZE CLAIMS: If you obtain one of the prizes stated in Rule #3, sign your full legal signature on the game card and send via certified mail (copy should be made for your records) along with your name and address to: Borland International Prize Claim, 196 Danbury Road, Wilton, CT 06897. All prize claims must be received or postmarked by February 15, 1987. (See Rule #12 for Trip for Two to America's Cup exception.)

5. REBATE CLAIMS: Rebates are good for products purchased from September 5, 1986 through March 31, 1987. The $10 rebate is good for any individual Borland product and the $15 rebate is good for any advertised Borland software bundle. To receive your rebate you must return your completed license agreement from the manual, this game card and dated proof of purchase to: Borland International, Game Card Rebate, 4585 Scotts Valley Drive, Scotts Valley, CA 95066. Upon receipt of the license agreement, game card and proof of purchase, Borland will send your check. Rebate is not valid with any other rebate or promotion offered directly from Borland.

6. VERIFICATION: All game materials are subject to verification. Game materials are void and will be rejected if not obtained through authorized, legitimate channels, and may be rejected if any part is reproduced, counterfeited, torn or altered in any way, or if materials contain printing, typographical, or mechanical errors. Decisions of the Redemption Center are final. Game pieces from any game other than the Borland Instant Winner Game may not be used in this game.

7. CONDITIONS OF PARTICIPATION: Material submitted becomes the property of Borland International. The submission of game pieces is the sole responsibility of the individual seeking verification, who is solely responsible for lost, late, or misdirected mail. All taxes, registration and inspection fees are the sole responsibility of the verified winner. Winners may be required to execute an affidavit of eligibility and name and likeness publicity release. By participating in the game you accept and agree to be bound by these rules and the decision of the Official Redemption Center which will be final.

8. ELIGIBILITY: Participation is open solely to residents of the United States 18 years of age and over, except employees and agents of Borland International, service agencies, and individuals engaged in the development, production, or distribution of game materials, The Merritt Group, Inc. and their immediate family or members of their households. Void in Vermont and where prohibited by law.

9. GAME SCHEDULE AND AWARD OF PRIZES: The Borland Instant Winner Game will commence on or about September 5, 1986 and end on January 30, 1987. It will officially end, however, when all game pieces are distributed. Verified game prizes will be awarded within thirty (30) days from the date of their receipt for verification at the Official Redemption Center. A major prize winners' list can be obtained by sending a stamped, self-addressed envelope to: Borland Instant Winner Game Winners' List, P.O. Box 7089, Wilton, CT 06897.

10. ODDS CHART: The odds of winning prizes are based upon obtaining the one rare game piece among the applicable number of game pieces.

PRIZE	Qty.	Total Value	Odds of Winning
Trip for Two to America's Cup or $10,000	1	$ 10,000.00	1 in 6,458,000
Suzuki 4W Samurai Convertible JA or $6,895	2	$ 13,790.00	1 in 3,229,000
AST Turbo Laser	1	$ 4,995.00	1 in 6,458,000
Toshiba Portable Computer	2	$ 6,898.00	1 in 3,229,000
AST Memory Boards	25	$ 15,025.00	1 in 258,320
Borland Products	1,000	$149,000.00	1 in 6,458
OVERALL TOTAL	1,031	$199,708.00	1 in 6,264

All remaining game cards will contain a $10 rebate good on any individual Borland product or a $15 rebate good toward any advertised Borland software bundle.

11. PRIZE DETAILS: Trip for two to America's Cup Races (or $10,000) will include coach seating round trip airfare on regularly scheduled commercial airline from San Francisco, California to Perth, Australia and up to two weeks hotel accommodations in Perth, Australia plus $4,500 spending cash. Winners will be responsible for obtaining visa, passport, and all other travel documents. Trip does not include meals, taxes, excess baggage charges and other hotel charges. Minor must be accompanied by parent or legal guardian.

Suzuki 4W Samurai Convertible JA Standard Equipment Package (or $6,895), verified winner will be responsible for all registration, insurance, and licensing fees. AST Turbo Laser, Toshiba Portable Computer Model #T1100; Toshiba Portable Computer Model #T3100; AST Memory Boards and Free Borland Products are non-substitutional except by sponsor due to product availability and all warranties and guarantees are subject to manufacturers terms. All prizes are non-transferrable. Winning consumer is responsible for all local, state and federal taxes.

12. SECOND CHANCE SWEEPSTAKES: There are two Second Chance Sweepstakes drawings scheduled to be conducted on December 31, 1986 and February 28, 1987. Random drawing from all entries received by December 30, 1986 will award trip for two to America's Cup Races (or $10,000). Random drawing from all entries received by February 26, 1987 will award two (2) Suzuki 4W Samurai (or $6,895). All remaining prizes that are unclaimed after February 15, 1987 will remain unclaimed. Send entry to: Second Chance Entry P.O. Box 870 Wilton, CT 06897.

If you have any questions concerning the Borland Instant Winner Game, call: 1-800-451-4471.

The Worldwide Programming Standard

Turbo Pascal Programming!

New Mac Version available!

Turbo Pascal now includes free 8087 support and BCD!

$10.00 Scratch 'n Win Rebate!

Turbo Pascal® 3.0

"For the IBM® PC, the benchmark Pascal compiler is undoubtedly Borland International's Turbo Pascal," says Gary Ray of *PC Week*. We and more than 500,000 other people around the world think Mr. Ray got that right. Since launch, Turbo Pascal has become the *de facto* worldwide standard in high-speed Pascal compilers. Described by Jeff Duntemann of *PC Magazine* as the "*Language deal of the century*," Turbo Pascal is now an even better deal than that—because we've *included* the most popular options (BCD reals and 8087 support). What used to cost $124.95 is now only $99.95! You now get a lot more for a lot less: the compiler, a completely integrated programming environment, and BCD reals and 8087 support—all for a suggested retail of only $99.95. And with a Scratch 'n Win $10.00 Rebate, you pay *only $89.95*—which really is the "language deal of the century"! Minimum memory: 128K.

$10.00 Scratch 'n Win Rebate!

Turbo Database Toolbox™

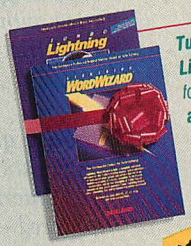
A perfect complement to Turbo Pascal, because it contains a complete library of Pascal procedures that allows you to search and sort data and build powerful database applications. Having Turbo Database Toolbox means you don't have to re-invent the wheel each time you write a Turbo Pascal program. It comes with source code for a free sample database—right on disk. The database can be searched by key words or numbers. Update, add, or delete records as needed. Just compile it and it's ready to go to work for you. (Shore Sails has more than 700 boat designs and rigs in their Database Toolbox. See front page story.) Suggested retail: $69.95. With a $10.00 Scratch 'n Win Rebate check back from us, *only $59.95!* Minimum memory: 128K.

Build Your Own Database Applications!

SPECIAL PRICES! AMAZING VALUE! ACT NOW!

It's the Works! Everything! The whole electronic enchilada! It's the **Jumbo Pack . . . Turbo Pascal 3.0, Turbo Tutor 2.0, Turbo Editor, Turbo GameWorks, Turbo Graphix** and **Turbo Database.** All 6 Turbo Pascal programs for only $299.95—or **only $284.95** with a $15.00 Scratch 'n Win Rebate! That's about $47.00 each and that's a deal!

Save a bundle on our bundles!



Turbo Lightning and **Lightning Word Wizard** for only $149.95! and an **amazing $134.95** after a $15.00 Scratch 'n Win Rebate!

$15.00 Scratch 'n Win Rebate on all Xmas packs!

SideKick and **Traveling SideKick** for only $125.00 but **only $110.00** after a $15.00 Scratch 'n Win Rebate!

Reflex: The Analyst and the new **Reflex Workshop** for only $199.95! And a $15.00 Scratch 'n Win Rebate cuts that down to **only $184.95!**

CIRCLE NO. 254 ON READER SERVICE CARD

BORLAND INTERNATIONAL

Vive la différence

YES! I want the best!

For credit card orders or the dealer nearest you

call (800) 255-8008

in CA call (800) 742-1133

Copies	Product	Price	Totals
__	Turbo Pascal 3.0 w/8087 & BCD	$99.95	$
__	Reflex: The Analyst	149.95*	$
__	Reflex Workshop	69.95*	$
__	Reflex, Reflex Workshop	199.95*	$
__	Turbo Prolog	99.95	$
__	Turbo Pascal for CP/M-80	69.95	$
__	Turbo Database Toolbox	69.95	$
__	Turbo Graphix Toolbox	69.95	$
__	Turbo Tutor 2.0	39.95	$
__	Turbo Editor Toolbox	69.95	$
__	Turbo GameWorks	69.95	$
__	Turbo Lightning	99.95	$
__	Lightning Word Wizard	69.95	$
__	Turbo Lightning, Lightning Word Wizard	149.95	$
__	SideKick	84.95	$
__	Traveling SideKick	69.95*	$
__	SideKick, Traveling SideKick	125.00*	$
__	SuperKey	69.95	$
__	Turbo Jumbo Pack	299.95	$
	Outside USA add $10 per copy		
	CA and MA res. add sales tax		$
	Amount enclosed		$

Prices include shipping to all US cities.

Carefully describe your computer system:

Mine is: __ *8-bit* __ *16-bit*

I use: __ *PC-DOS* __ *CP/M-80* __ *MS-DOS* __ *CP/M-86*

My computer's name and model is:

The disk size I use is: ☐ 3½" ☐ 5¼" ☐ 8"

Payment: VISA MC Money order Check

Credit card expiration date ____/____

Card #

Name:

Shipping Address:

City:

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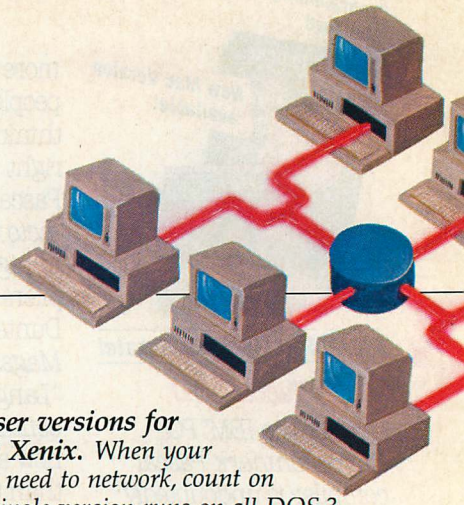

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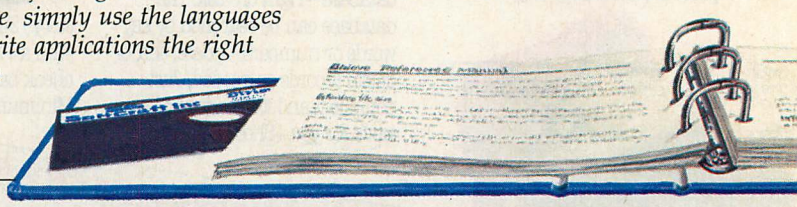

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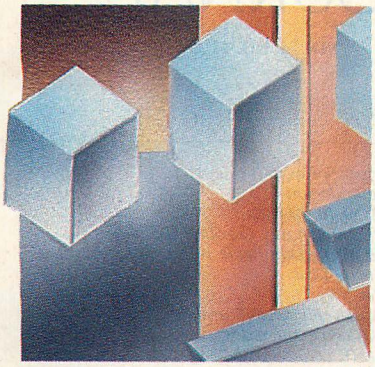
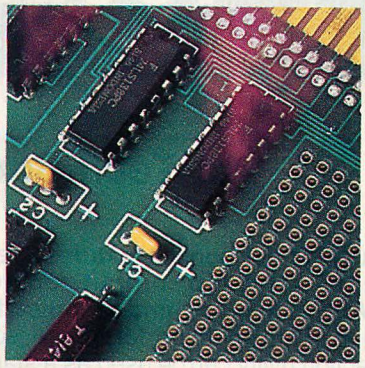
NOVEMBER 1986 VOLUME 4, NUMBER 11



UNIX Serial Device Filters 164

LAN Gateways 74



End-to-End Design 96

Cover Illustration · Andy Levine

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PLAGUES OF BIBLICAL PROPORTIONS

The first and most difficult plague was impossible to trap with software debuggers. These were carnivorous bugs which randomly overwrote programs, data, even the debugger. Nastiest were the ones that slipped in once every few hours, or changed their behavior after each new compile. Forty days and forty nights of recompiling, *trying something else*, caused many a would-be resident of the city to run screaming into the wilderness, never to be heard from again.

Second came the plague of not knowing where the program was, or where it had recently been. This compounded the first plague: How could anyone know *what* caused the random memory overwrites? Add to this random interrupts and timing dependencies, and you begin to understand *The Fear* that gripped the city.

Then came the last plague, which brought the wizards to their knees before they even started debugging. Their towering programs consumed so much memory, there wasn't enough room for their symbol table, let alone debugging software. Even if they could get past the first two plagues, this one killed their firstborn software.

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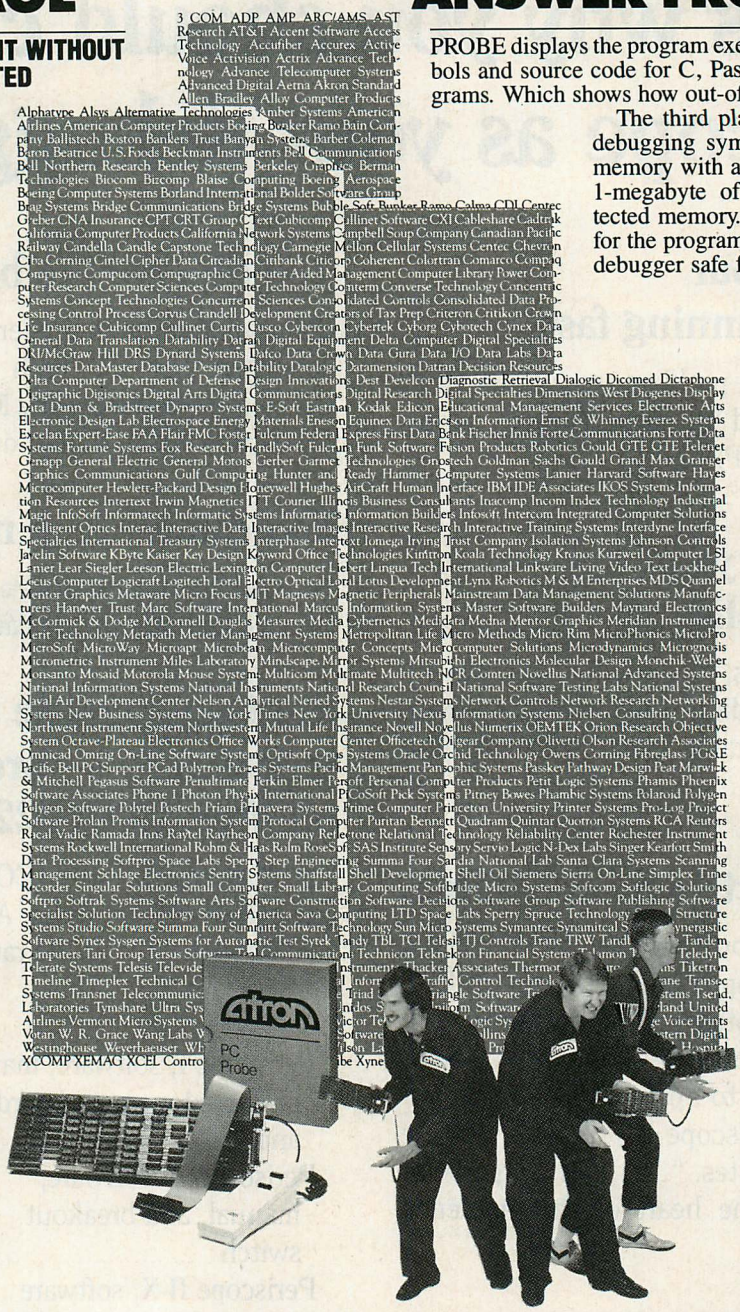

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Long Live the 286! (Part 2)

The 80386 notwithstanding, the 286 has critical mass.

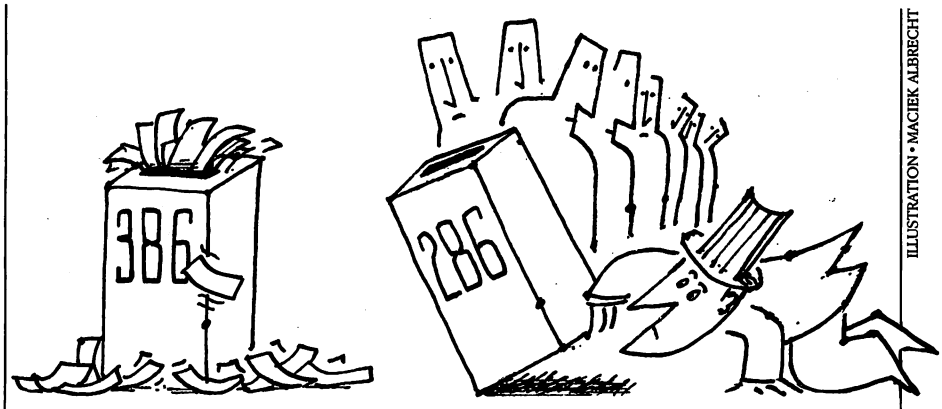

ILLUSTRATION • MACIEK ALBRECHT

As contributing artist Maciek Albrecht's illustration should clearly indicate, readers' votes in reply to the August Directions ("Long Live the 286," p. 9) were heavily in favor of immediate migration to the 80386, by a margin of about three to one. You might well ask, therefore, why the title of this column is not "Long Live the 386!".

I knew my August editorial would be controversial, but the nature of the responses was surprising. The minority who voted 286 generally supported my arguments, most often the one about return on investment. The majority, however, was quite vituperative, accusing me of retarding the pace of the advancement of technology and generally questioning my intelligence, my common sense, and even my ancestry.

I am left with a tough question: what is the basis of the intense desire in the *PC Tech Journal* audience for the 386? Part of the answer is simple: the promise of the 80286's 16MB physical and 1GB logical address space has not materialized. And why? That complex answer has to do with software.

Where are you, protected mode? No advance in basic hardware technology is going to be possible unless the body of software written to the DOS model can come along for free. Imagine the despair of the financial planner whose machine is suddenly much more powerful and considerably bigger, but upon which Lotus 1-2-3 stubbornly refuses to run. The challenge for the operating system developer, then, is to keep a migration path for existing software while simultaneously building a superior platform for advanced applications.

At first, it was thought that a protected mode DOS (for clarity, let's call this DOS 286) could be developed that would allow an unlimited number of DOS 3.x applications to run as tasks. As time went on, however, the DOS 3.x environment was recognized as being somewhat "dirty"; this was not because DOS was inherently problematic, but because the applications built for it broke rule after rule, including hardware violation of video memory.

The overhead necessary to control multiple, less-than-well-behaved DOS 3.x applications was therefore exorbitant, slowing an 8-MHz 80286 down to PC and 8088 levels. This overhead prevents a clean migration to a protected-mode environment and keeps us using ATs only as fast PCs.

The 80386 solves this problem elegantly. Make no mistake: Microsoft and Intel must have been talking. The current 386 chip is different than its specification of three years ago; the influence of the most popular operating system and its creator has most certainly been felt. What appears in the 386 is a hardware feature called *Virtual-86*, a processor mode that, with relatively simple control software, allows as many DOS 3.x, 640KB programs to run as the user might desire—and run concurrently, bad behavior and all.

In addition, Virtual-86 can be activated very easily from a protected-mode operating system (call it DOS *386*). This allows a clear and simple migration path from DOS to an environment that offers the full power of the 386 at the same time it supports all previous applications. The memory management unit (MMU) of the 386 is so powerful that Lotus/Intel/Microsoft expanded memory can be emulated, allowing DOS 3.x applications that use it to run as well. Of course, the 386 fully supports 286 applications and systems, so it will run the predecessor DOS 286 quite properly.

Another trick Virtual-86 mode allows is the creation of a relatively simple control program that lets multiple DOS 3.x applications run concurrently without supporting any native, protected-mode applications. Instead of cramming several programs into 640KB, each program appears to be running in its own machine and gets all the memory DOS 3.x can support.

Given those advantages and benefits, the 386 should be it and the conversation should be over. The final theoretical nail in the 286's coffin is the 386 add-in board, such as the new Intel Inboard 386/AT, which converts a normal AT-class machine into a "386 AT"; although the performance of such a configuration may not match that of a machine designed around the 386, all the functionality of the 386 is delivered nevertheless. Why is it then, that the editor of *PC Tech Journal* keeps waving a 286 flag? Can he not see the inevitability of his own arguments?

Speak softly and carry a critical mass. I may yet again anger the 386 advocates by

stating that desktop computers built upon the 80286 are an important segment of the market. Why? Because there are so many of them.

Microsoft claims that about 1 million 286 machines are installed today and that about 3.5 million will be installed by mid-1987. Estimates from Future Computing are similar; Dataquest, whose figures are typically conservative, are somewhat smaller. The 3.5 million figure may seem high, but it is quite believable. Certainly the 286 is rapidly replacing the 8088 as the most important commodity microprocessor. (IBM has recently found a place in its new XT/286 for its inventory of 6-MHz 80286 chips to settle.)

An installed base of 3.5 million machines with a standard architecture is definitely a critical mass. It should be clear, even to those who voted for the 386, that the 286 is (or at least quickly will be) ubiquitous.

By contrast, the 80386 had an installed base of almost 0 on the day Compaq announced the Deskpro 386. Given Intel's own projections about its ability to deliver silicon, I believe Microsoft is correct with its estimate of a quarter-million 386 machines by mid-87. (Again, other sources of information tend to support that guess.) In other words, by the sixth anniversary of the IBM PC the 286 will have an installed base 14 times larger than the 386. While it is true that most estimates show a rapid increase in 386 machines, those same estimates show the dominance of the 286 and its market share not declining for at least two years.

Granted, the 80286 is not as powerful as its newer sibling, but that is not to say that the 286 is not a capable processor in its own right. Given the proper operating system, the 286 can deliver on the promise of its MMU and its substantial physical memory capacity. Several versions of the chip are even suitable for higher clock rates, making possible some raw performance gains.

You may think that this editor does not care for, and is not impressed by, the new Compaq Deskpro 386. Bite your tongue. That machine will rapidly find its way into *PC Tech Journal*'s lab and is already being considered as the foundation for a new PCTECHline as well as our network servers. As a former software developer, I certainly crave the additional raw power inherent in the Deskpro 386; development shops surely will comprise a major portion of Compaq's early orders. The editor of this very blue computer magazine might even decide to put a non-IBM computer on his desk!

But he still has a 286-based system, as does each member of his staff. So do many of you. Furthermore, our most current research (admittedly performed prior to Compaq's announcement) shows intense interest in AT-class machines along with limited but growing interest in 386 futures. Let's face it: 286s will be with us for a long time. We're going to be using them, and expecting them to do a lot of work for us.

The folks at Microsoft must be having quite a time deciding what to do. Should they go straight for the 386 and ignore the 286? Or should they build both DOS 286 and DOS 386? Either way, they face the enormously difficult task of building a protected-mode DOS.

Getting from DOS 3.x to DOS 286/386 is the hard part; advancing from 286 to 386 is (relatively) straightforward and represents an application migration strategy that is even easier.

With millions and millions of 286-based machines out there, I have to believe that we will have an operating system that finally lets us exploit the power and capability our desktops have had for the past two years.

At least, I hope I'm right.

XT/286: SIGN OF THE TIMES

The introduction of the IBM Personal Computer XT model 286 was greeted with hoots and catcalls from most quarters. A frequent objection has been price: at just under $4,000, many think the machine is just too expensive in the face of the clone wars. Another complaint is that full-height add-in boards designed for the AT will not fit in the new XT/286.

The new machine is part XT (the box) and part AT (a slightly revised motherboard). This seems to signal confusion, but IBM is sending us three important messages.

The first is an obvious one. My own theory of price points on the desktop is that a usable machine must be available at $1,500, $3,500, and $5,500. IBM has the AT Model 339 at $5,295, so the upper end is covered. At the moment it has nothing at the $1,500 point, although just about everyone I talk to thinks IBM could attack the low end with a basic XT model if it really wanted to. Not much is available at $3,500 either. That's about where the original XT was not long ago, but the XT is not particularly attractive by today's standards of performance and capacity.

Suddenly, IBM does have an entry, albeit at $4,000. Given my price points, I have to say the machine is priced a bit high. It is interesting nonetheless. It has the 286 processor so it has a future. Although it is clocked at 6 MHz, it has zero-wait-state memory and thus turns in CPU performance close to that of an 8-MHz machine. It is equipped with four half-height bays for disk devices. It has the new keyboard. And it even fits in the same amount of desk space as the PC or XT, something the AT cannot claim.

With something at the $1,500 point, IBM would have a formidable lineup, one that would help restore some of its market share. The XT/286 helps. Eroding its price by $500 would help even more.

The second message is very important. IBM is saying that the 80286 is it, and quietly admitting that the days of 8088-based desktops are coming to a close. The *PC Tech Journal* audience certainly feels that way.

The third message is the most important. It is manufactured by IBM. Big Blue has never been shy about the memory chips in the PC family—it has used commodity chips from a variety of vendors. This time, however, IBM has used its proprietary packaging technology to create 256KB boards the size of a stick of chewing gum. Two of these are used in the XT/286; the other 128KB is conventional RAM.

IBM has considerable resources in semiconductor design, manufacturing, and packaging. I think Big Blue has chosen to flex its giant muscles just a hair, for no other reason than to remind us what it is truly capable of. It surprises me that the PC took so long to get into custom semiconductor; we did not see it until the PC Convertible. It also surprises me that IBM has not cost-reduced its machines in other ways, such as by including the serial and parallel ports on the system board.

These are messages we should not forget. They are certainly messages IBM's competitors should not forget as they plot their future courses. But just as importantly, IBM should look more closely at these—its own—messages, and take heed.

—*WF*

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*The benchmark procedure was adapted from "Benchmarking Database Systems: A Systematic Approach" by Bitton, DeWitt and Turbyfill, December 1983.

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Others: IQ LISP ($155), UNX LISP ($59), IQC LISP ($269), WALTZ LISP ($149)

AI-Prolog

APT - Active Prolog Tutor - build applications interactively	PC	$ 65
ARITY Standard - full, 4 Meg Interpreter - debug, C, ASM	PC	$ 350
COMPILER/Interpreter-EXE	PC	$ 795
With Exp Sys, Screen - KIT	PC	$1250
LPA MacProlog - Complete incremental compiler and an interpreter	MAC	$ 295
LPA MicroProlog - intro	MS	$ 99
LPA MicroProlog Prof. - full memory	MS	$ 359
Prolog-86 - Learn Fast	MS	$ 89
Prolog-86 Plus - Develop	MS	$ 229
TURBO PROLOG by Borland	PC	$ 69

Others: Prolog-I ($95), Prolog-2 ($859)

Editors for Programming

BRIEF Programmer's Editor - undo, windows, reconfigure	PC	Call
EMACS by UniPress - powerful, multifile, MLISP. Source: $929		$ 299
Epsilon - like EMACS	PC	$ 169
Kedit - like XEDIT	PC	$ 109
Lattice Screen Editor-multiwindow multi-tasking Amiga $100	MS	$ 109
PC/VI - Custom Software	PC	$ 129
PMATE - power, multitask 80/86		$ 149
SPF/PC - fast, virtual memory	PC	$ 139

FEATURE

386 Assembler/Linker - Native or Cross Development. Full Microsoft MASM compatible plus 386/387 extensions. PC $ 495

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C Support-Systems

Basic-C Library by C Source	MS	$139
C Sharp - well supported, Source, **realtime,** tasks	PC	$600
C ToolSet - DIFF, xref, source	MS	$ 95
The HAMMER by OES Systems	PC	$179
Lattice Text Utilities	PC	$ 95
Multi-C - multitasking	PC	$149
PC LINT-checker. Amiga $89,	MS	$119
SECURITY LIB - add encrypt to MSC. C86 programs. Source $250	PC	$125

Fortran & Supporting

Forlib+ by Alpha - graph, comm.	$ 59
MACFortran by Microsoft - full '77	$229
MS Fortran - well liked, solid	**$219**
No Limit - Fortran Scientific	$119
RM Fortran - enhanced "IBM Ftn"	$395
Scientific Subroutines - Matrix	$149

MultiLanguage Support

BTRIEVE ISAM	MS	$199
BTRIEVE/N - multiuser	MS	$469
CODESIFTER - Execution PROFILER. Spot bottlenecks.	MS	$109
Dan Bricklin's Demo Program	PC	$ 65
HALO Graphics - 115+ device interfaces, rich, printer. Specify language interface	PC	$219
Microsoft Windows Software Development Kit	PC	$399
PANEL - data validation, no royalties Xenix $539,	MS	$229
Pfinish Performance Analyzer	MS	$249
PLINK-86 - a program-independent overlay linker to 32 levels.	MS	$249
PLINK-86 PLUS - incremental	MS	$369
PolyLibrarian	MS	$ 85
PVCS Version Control	MS	$329
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ZAP Communications - VT 100, TEK 4010 emulation, file xfer.	PC	$ 95

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Cambridge LISP	Amiga	$200
Lattice C	ST., Amiga	$139
Lattice Text Utilities	Amiga	$ 75
Megamax - tight, full	ST	$200

RECENT DISCOVERY

Unishell - Bourne UNIX shell script compiler translates to C and runs faster. Portable, hand optimizable code. Use as C program generator. PC $395

C Language-Compilers

AZTEC C86 - Commercial	PC	$499
C86 by CI - 8087, reliable	MS	$299
Datalight C - fast compile, good code, 4 models, Lattice compatible, Lib source. Dev'rs Kit	PC	$ 85
HOT C - new, intriguing	PC	$ 85
Lattice C - from Lattice	MS	$299
Mark Williams - w/debugger	MS	$399
Microsoft C 4.0 - CodeView	MS	$299
Wizard C - full, fast.	MS	$389

C Language-Interpreters

C-terp by Gimpel - full K & R, .OBJ and ASM, large progs.	MS	$239
INSTANT C - Source debug, Edit to Run-3 seconds, .OBJs	MS	$389
Interactive C - interpreter, editor	PC	$225
Introducing C - learn C quickly	PC	$109
Run/C Professional -	MS	$189
Run/C Lite - improved	MS	$109

C Libraries-General

Blackstar C Function Library	PC	$ 79
C Essentials by Essential	PC	$ 85
C Food by Lattice-ask for source	MS	$109
C Scientific Subroutines - Peerless	MS	$139
C Tools Plus (1&2)	PC	$149
C Utilities by Essential - Comprehensive screen graphics, strings. Source.	PC	$139
C Worthy Library	MS	$269
Entelekon C Function Library	PC	$119
Greenleaf Functions - portable, ASM		$139
PforCe by Phoenix - objects	PC	$299

C Libraries-Files

FILES: C Index by Trio - full B+ Tree, vary length field, multi compiler		
/File is object only	MS	$ 89
/Plus is full source	MS	$349
CBTREE - source, no royalties	MS	$ 99
CTree by Faircom - no royalties	MS	$339
dbVISTA - full indexing, plus optional record types, pointers, Network.		
Object only - MS C, LAT,	C86	$159
Source - Single user	MS	$429
Source - **Multiuser**	MS	$849
dBASE Tools for C	PC	$ 79
dbc Isam by Lattice	MS	$199

FEATURE

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Paint your screens with the screen builder, and save them to a DOS file accessible with a single call, or define screens within your program at runtime — even combine the techniques for still greater power (lets you modify screens on the fly). Form Master supports an unlimited number of screens (with 512K RAM, you can define up to 64 25-line virtual screens).

Each screen can have over 2000 fields, and can be up to 16.5 physical screens in length; and you can use the same screen with each language. Use the default attributes (like reverse video, underline, etc.) or choose from any of 256 possible attributes.

Permits flexible function key definition, forms larger than the physical screen, toggling field colors and attributes at runtime, and allows you to switch between screens without losing any data. Modify screens whether or not they are being displayed. With Form Master you can generate screen or field-specific help screens.

Get a cleaner, FASTER user interface with Form Master.

Form Master is DESQview, TopView, and MS Windows compatible. Lattice, MS C (2.xx+) (all models of C supported), APL*PLUS/PC, assembler — BASIC and Pascal soon. Call 818-989-5329 for a $3 demo with tutorial.

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The highly efficient design of Synergy by Matrix gives you the benefits of powerful graphics, windows, pull-down menus, dialog boxes, sophisticated text and icon management, math support, multitasking, and SPEED, all for an incredibly small **12K RAM** requirement.

The Synergy Runtime provides character and graphics support for menus, windows, dialog boxes, and more, so you can write programs that work in either mode, with very reasonable, low runtime fees.

Functions include: window management with capabilities like tile and overlap, variable size and placement, process management, to support multitasking and sub-process generation, menus, dialog, and icon management, graphics, text (including a variety of fonts and sizes), and console management.

The Synergy Development Toolkit is a collection of sophisticated tools designed for software developers writing new applications using Synergy, or modifying existing applications to take full advantage of Synergy. Tools include: graphics resource editor for creating and modifying icons and text fonts, graphics resource compiler to construct and manage resource data files, font compiler and manager, debugging tools, sample library, and more.

Supports IBM or Microsoft Macro Assemblers, Turbo, IBM, and Microsoft Pascal, IBM and Microsoft BASIC, Lattice and Microsoft C, and dBASE II and III. CGA, EGA, and Hercules monochrome graphics support.

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EXSYS, Inc. has built a stable and complete toolkit by listening to users and examining what they need. One of the first Expert System Shells for the PC, EXSYS provides the features of just about all of its combined competitors, plus the documentation and examples you will need to learn in this field.

UNLIMITED FEATURES? EXSYS supports backward chaining of IF/THEN/ELSE rules, full math support, probabilities, explanations, the ability to call external programs including spreadsheets, database managers, or custom-written front ends with data passed to and from the external program, plus the ability to handle substantial applications of up to 5,000 rules. All user input is either English text, menu selection, or algebraic expression.

The systems developed can explain why information is needed and how it will be used. The ability to "change and rerun" allows expert system modelling of problems. Written entirely in C, EXSYS provides very high speed execution and efficient memory utilization.

But if these features are not enough, use the interface to Lotus, dBASE, BASIC, C, or any other .EXE or .COM file. Already in use at over 1,000 sites with many complex and powerful expert systems developed. Several expert systems have been marketed with a low-cost runtime license. Single computer use is only $349. Unlimited runtime distribution is available for an additional $539. Call (505) 836-6676 for **$15 demo.**

EXSYS **PCDOS $349**

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-experienced C/dBASE programmer

If you need the portability, speed, and control of C, but all your code is written in dBASE, dBx is for you. Including a translator, C libraries and utilities, dBx produces a clean, maintainable translation of most of your programs. You complete translation then rewrite sections to take advantage of C power, flexibility.

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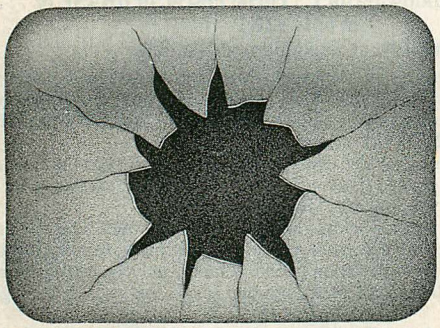
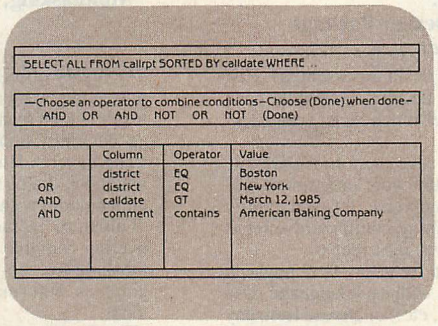
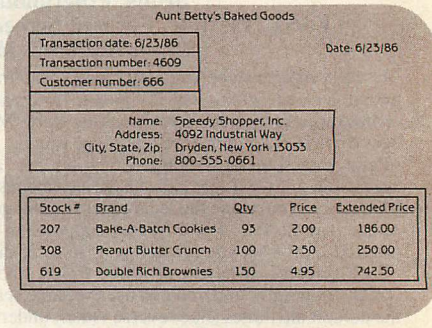


A typical DBMS user's screen, after the 497th line of code.



An R:BASE System V Prompt-By-Example (PBE) screen. With PBE's query capabilities, you can retrieve just the information you need. Without programming.



A data entry screen designed without programming, using Forms EXPRESS.

With most database management software for the IBM PC family and compatibles, you're quickly confronted with a painful reality: the only way to make your package live up to its promise is to learn its programming language. Which can take months. Then you have to write the code, line after frustrating line.

But now, there's R:BASE™ System V. And for the first time, you can quickly create programs that automate your most important data management tasks. Without programming.

Of course, with R:BASE System V, you can enter, query, and report on data in a non-automated, ad hoc fashion. Without programming. And there's a high-level procedural language for programmers. But that's just the beginning.

R:BASE SYSTEM V. IT GIVES NON-PROGRAMMERS POWERFUL PROGRAMS.

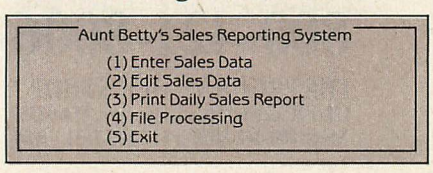
With the EXPRESS System in R:BASE System V, you can access powerful features, without programming, that other data management software can't touch.

With Definition EXPRESS, you can build a database structure with advanced features like computed columns, and *searchable* note fields. VIEWS that combine up to five tables in a single, powerful table. Data validation rules that check incoming data for errors. All without programming.

Then you can use Forms EXPRESS to create customized data entry forms. The forms you create can load data into five different tables, linked in One-To-Many relationships. You can also include scrolling regions, custom borders, and custom colors, all without programming.

And with Reports EXPRESS, you can design reports exactly the way you want. And see what they'll look like, right on the screen. To see how complex your reports can be, take a close look at the example at the end of this page.

Finally, you can tie it all together with Application EXPRESS. First, you design your own multi-level system of menus. Your first menu level might look like this:



For each menu choice, you assign an action. For example, to define menu choice #3, choose the action "PRINT," select the report you just created in Reports EXPRESS, and specify the appropriate data sorting and selection criteria. Then Application EXPRESS automatically writes the program code.

Which means you've just created a very sophisticated program to deliver the full power of your DBMS. And you've done it all without learning how to program. From this point on, every time you want to run a report, all you do is choose item #3. With one simple keystroke, you've got it.

R:BASE SYSTEM V. IT GIVES PROGRAMMERS A POWERFUL ENVIRONMENT.

If you're an experienced programmer, you can use R:BASE System V to tackle the most demanding applications. You can use Application EXPRESS to create prototypes faster than with any other microcomputer-based DBMS.

There's a high-level procedural language, and a full set of relational operators that can leverage up to 80 tables, all of which can be open at once. While you're racing along, a data dictionary

DBMS PROGRAMS RFUL DBMS PAIN.

keeps track of the action. Automatically.

For demanding analyses, there's a set of 70 math, statistical, financial, scientific, and string manipulation functions. You also get more capacity for your data. Comprehensive menu-driven import/export capabilities. Superior relational power. And much, much more.

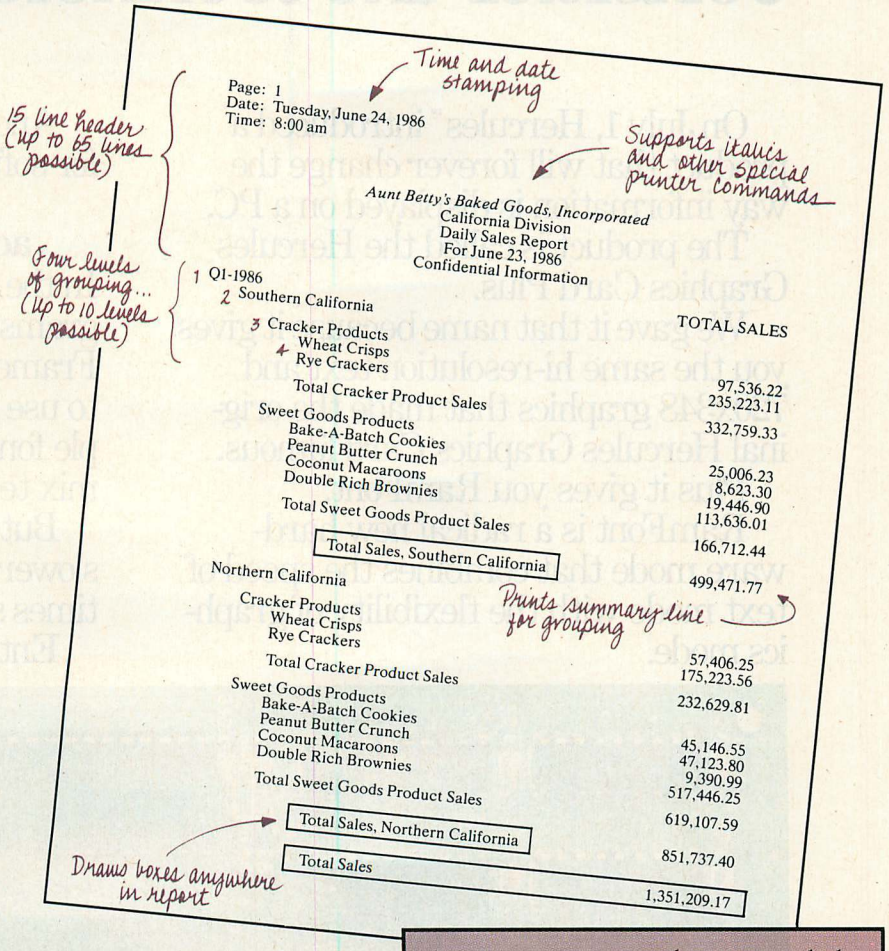
THE MOST POWERFUL DBMS FOR ONE USER OR A WHOLE NETWORK— ALL IN ONE PACKAGE.

In addition to its standalone personal computing power, R:BASE System V has all the features you need to share data on a local area network (LAN) built right in. When you're ready to network—now or later—this is the only DBMS package you'll ever need. And no matter how many users you add, you'll never have any growing pains. Because an unlimited number of users, attached to a LAN, can access R:BASE System V.

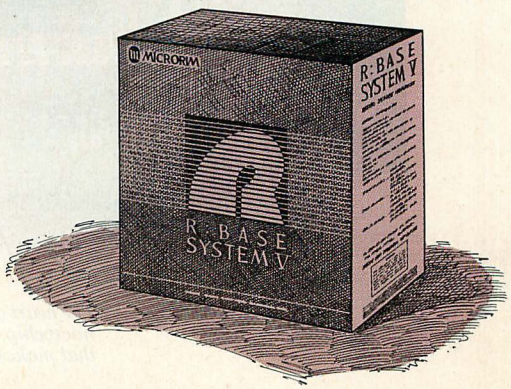
SEE FOR YOURSELF: $15.95.

We're confident you'll find R:BASE System V the shortest distance to your data management solution. Visit your computer dealer for a trial run. Or, if you prefer, we'll send you a Trial Pack for only $15.95, plus shipping. It's a fully functional, row-limited version of R:BASE System V. Just call 1-800-547-4000, Dept. 994. In Oregon or outside the U.S., call 1-503-684-3000, Dept. 994.

What if you already own R:BASE 5000? If you bought your copy before June 30, 1986, you can trade it for the full power of R:BASE System V. For only $99. (Offer expires January 31, 1987.) Just give us a call at 1-800-248-2001. Outside the U.S., call 1-206-885-2000.



A program to print this report daily, with a one-keystroke menu pick, was developed without programming using R:BASE System V's EXPRESS Technology. Whether you know how to program or not, R:BASE System V is the shortest distance to your data management solution.



NEW R:BASE SYSTEM V FROM MICRORIM

CIRCLE NO. 143 ON READER SERVICE CARD

Before you consider the new Hercules Graphics Card Plus, consider the technology behind it.

On July 1, Hercules™ introduced a product that will forever change the way information is displayed on a PC.

The product is called the Hercules Graphics Card Plus.

We gave it that name because it gives you the same hi-resolution text and 720x348 graphics that made the original Hercules Graphics Card famous.

Plus it gives you RamFont.™

RamFont is a radical new hardware mode that combines the speed of text mode with the flexibility of graphics mode.

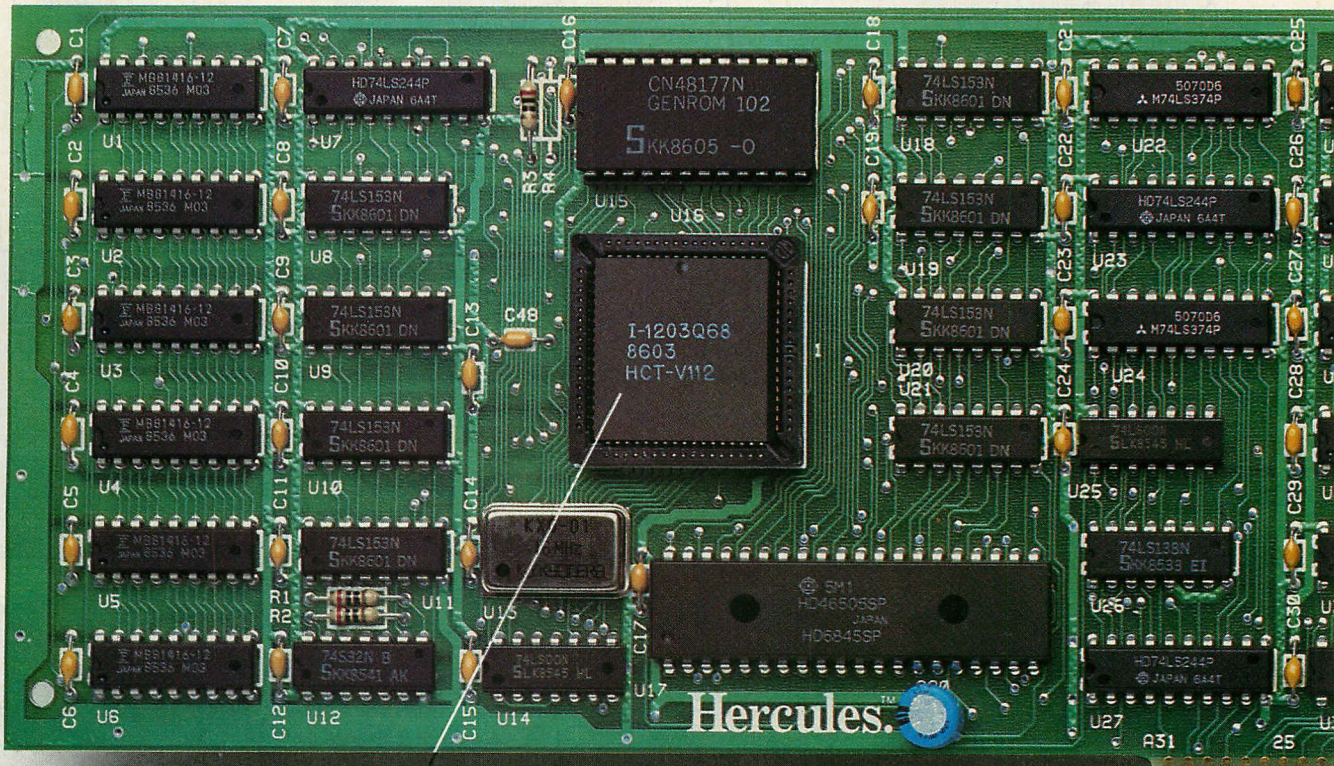
And opens up a whole new world for software.

The world according to RamFont.

In the old days (before July 1), programs like Lotus® 1-2-3®, Symphony,™ Framework™ and Microsoft® Word had to use graphics mode to display multiple fonts and variable text sizes, or to mix text with graphics.

But graphics mode is a whole lot slower than text mode. Up to eight times slower.

Enter RamFont.



Actual Size

The heart of the Graphics Card Plus: the V112 microchip, Hercules' next generation video processor that makes the RamFont mode possible.

It lets all the programs we just mentioned (and plenty more in the future) do all the things we just described, all on one screen.

At precisely the same speed as text mode.

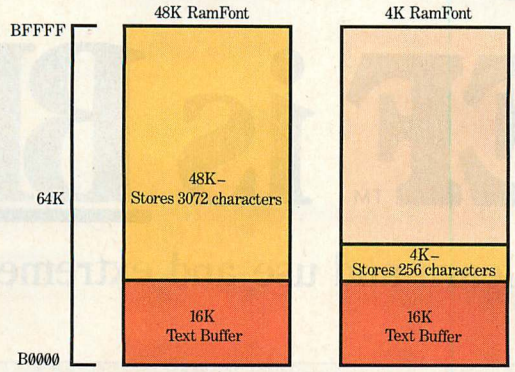
How RamFont works.

Like text mode, RamFont uses a 16-bit word to represent a character on the display.

Unlike text mode, however, the 48K RamFont mode uses a 12-bit character code instead of an 8-bit code.

Which allows you to choose from an astonishing 3072 different characters.

While setting the size of your screen cells from eight to nine pixels wide and from four to 16 scan lines tall.



The new RamFont mode displays 3072 programmable characters at the speed of text mode, or replaces the standard character set with one of your choice in 4K RamFont mode.

To help you design your own RamFont characters and symbols, we've included a font editor called FontMan.™

Along with a set of 25 sample fonts to start your library.

And since the 4K RamFont mode can accept 8-bit character codes, running your text mode software with your favorite font is as simple as loading it into RAM.

Just for the record, RamFont supports the standard character attributes of reverse, high-intensity, blink and underline.

Plus two new RamFont attributes: boldface and strike-through.

What price success?

While we're on the subject of technological breakthroughs, let's not forget the suggested retail price.

Think of it. You get everything the original card gave you.

Plus RamFont.

Plus FontMan.

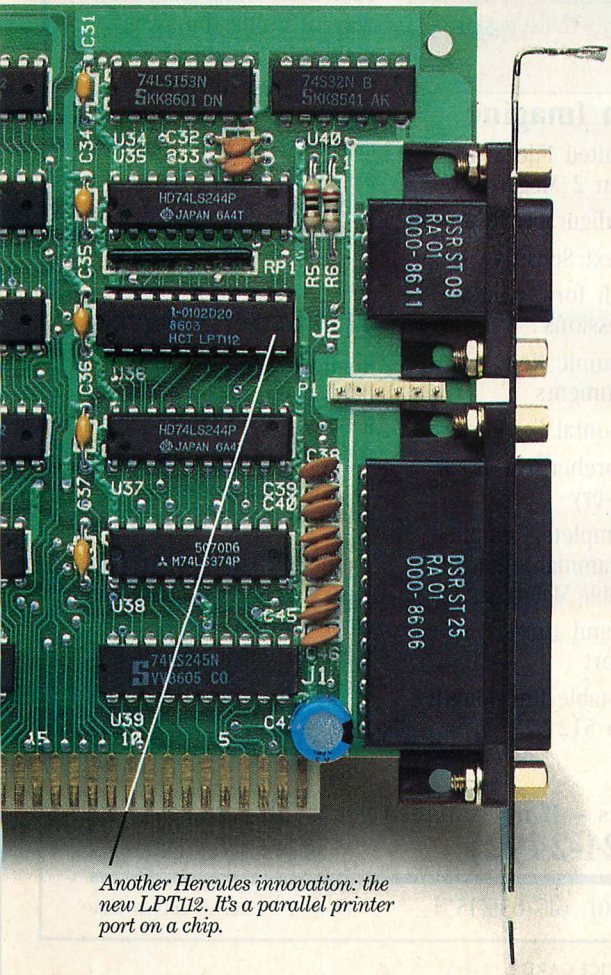
Plus a free printer cable.

Plus a parallel printer port that you can now disable if there's a conflict with another port in your system.

$299.
Suggested retail price.

All for just $299—about half the price of the original Graphics Card.

If you haven't gone into shock, call 1-800-532-0600 ext. 211 for the name of an Authorized Hercules Dealer near you and we'll rush you our free info kit.



Another Hercules innovation: the new LPT112. It's a parallel printer port on a chip.

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CIRCLE NO. 242 ON READER SERVICE CARD

Now You Know Why BRIEF™ is BEST

"BRIEF is simple to learn and use and extremely sophisticated."
PC Magazine, July 1986

The Program Editor with the BEST Features

Since its introduction, BRIEF has been sweeping programmers off their feet. Why? Because BRIEF offers the features **MOST ASKED FOR** by professional programmers. In fact, BRIEF has just about every feature you've ever seen or imagined, including the ability to configure windows, keyboard assignments, and commands to **YOUR** preference. One reviewer (David Irwin, DATA BASED ADVISOR) put it most aptly, "(BRIEF)...is quite simply the best code editor I have seen."

REGULAR EXPRESSION SEARCH

Regular expression searching is one of BRIEF's most powerful features. A regular expression is a series of "wildcards" that match pieces of your text. BRIEF supports a full set of regular expression characters similar to those found in UNIX including: beginning an end of line, groups, and the "closure" and "or" operators.

As Steve McMahon explained in Byte, "Not only does BRIEF make use of this marvelously general regular expression notation in its search facility, but its pattern recognition extends to its replacement (or translation) facility." "The usefulness of this facility for programmers who deal constantly with the regular expressions of formal languages is obvious..."

Every Feature You Can Imagine

Compare these features with your editor (or any other for that matter).

- FAST
- Full UNDO (N Times)
- Edit Multiple Large Files
- Compiler-specific support, like auto indent, syntax check, compile within BRIEF, and template editing
- Exit to DOS inside BRIEF
- Uses all Available Memory
- Tutorial
- Repeat Keystroke Sequences
- 15 Minute Learning Time
- Windows (Tiled and Pop-up)
- Unlimited File Size –(even 2 Meg!)
- Reconfigurable Keyboard
- Context Sensitive Help
- Search for "regular expressions"
- Mnemonic Key Assignments
- Horizontal Scrolling
- Comprehensive Error Recovery
- A Complete Compiled Programmable and Readable Macro Language
- EGA and Large Display Support
- Adjustable line length up to 512

Program Editing YOUR Way

A typical program editor requires you to adjust your style of programming to its particular requirements – NOT SO WITH BRIEF. You can easily customize BRIEF to your way of doing things, making it a natural extension of your mind. For example, you can create ANY command and assign it to ANY key – even basic function keys such as cursor-control keys or the return key.

The Experts Agree

Reviewers at BYTE, INFOWORLD, DATA BASED ADVISOR, and DR. DOBB'S JOURNAL all came to the same conclusion – BRIEF IS BEST!

Further, of 20 top industry experts who were given BRIEF to test, 15 were so impressed they scrapped their existing editors!

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CIRCLE NO. 130 ON READER SERVICE CARD

Nine-track Tape Systems

A time-tested storage technology adds commands PC users to mainframes and minicomputers. These eight subsystems offer consistent performance and several user data storage and transfer.

ROGER ADDELSON

Digitizing Analog Data

Data acquisition boards from seven manufacturers are examined from a hardware point of view. Their specific performance characteristics help a user select a suitable board for a given application.

ERIC M. MILLER

DATA ADJUSTMENT

I was surprised to see major errors and omissions in the review of some of our Analog Connection PC data acquisition cards in your May 1986 issue ("Digitizing Analog Data," Eric M. Miller, p. 52). The article was generally favorable, but I am used to a higher quality review from *PC Tech Journal*. The reviewer did not recommend the cards for general purpose use when, in fact, they represent a breakthrough in price, performance, and ease of use. Our cards have several unique features that make them more accurate and easier to install than any of the competing cards.

The biggest error in the article was the statement that except for the 50-mV and 25-mV ranges, "all other ranges for the boards are accurate to only 1 percent (approximately 7 bits)." Although this was true on an obsolete version of the 14-bit card, the cards that were reviewed were much better: .1 percent for the 14-bit card and .05 percent for the 16-bit card. The reviewer did not read the documentation properly and obviously did not run a test for accuracy. Because this specification includes not only the linearity error, but also the calibration and drift, our cards are *more* accurate than others reviewed.

When all the sources of error are considered, our 12-bit card, which was not reviewed, offers higher overall accuracy than one of the popular 16-bit cards. Our 16-bit ACPC-16 card is more than twice as accurate as our 12-bit card in addition to having 16 times better resolution. No mention was made of the fact that our integrating converter keeps noise low enough to provide true 16-bit resolution. Other 16-bit cards using successive approximation converters have 4 bits of noise, limiting their useful resolution to 12 bits.

Another error was the statement that for all of the reviewed boards, "The user should calibrate the data acquisition board upon its arrival. Another calibration should take place after one month, then yearly." This may be true for the other cards, but our Analog Connection cards are factory calibrated and the accuracy specifications apply without user calibration. Our cards incorporate automatic zero and full-scale calibration on the board. We guarantee the specified accuracy for two years.

The ACPC-16 is not the same as the 14-bit card as stated. Although the analog input section is similar, the 16-bit card is 100 times faster with a resolution that is 4 times higher. Its accuracy is double that of the 14-bit card on voltage ranges and 3 times better on current ranges. The interface to the computer was totally redesigned and, unlike the 14-bit card, works on the PC, PC/XT, PC/AT, and compatibles.

The author says that the on-board reference, which is conveniently brought out to the terminal box, is not buffered and "its connection requires great care." The reference *is* buffered, is protected from short circuits, and incorrect connection of this reference does not affect the accuracy of the card. In fact, this stable reference can power external transducers.

I do not contest all negative comments; I agree that none of the reviewed cards is perfect. For example, the connection of the terminal boxes to the card was difficult. We have alleviated this problem with a modification of the bracket that connects the card to the back of the computer.

The reviewer did commend our data acquisition and control program and our manual. He also accurately identified the cold junction compensation on the terminal box as providing the best thermocouple interface. The Strawberry Tree cards are good choices for high-level as well as low-level signals and thermocouples.

Walt Maclay, president
Strawberry Tree Computers
Sunnyvale, CA

The manual that was sent with the 14-bit card clearly states the accuracy as reported in the article. The 16-bit card is accurate only to within 11 bits, as indicated in table 1.

On the point of resolution, I did emphasize that the A/D converter on the Strawberry Tree boards offers a departure from the predominant successive-approximation types. I also pointed out that resolution and conversion time can be traded off in order to meet special signal requirements.

I admonish all users to calibrate on a periodic basis. Although a manufacturer may "guarantee" specified accuracy for an extended period, that guarantee will only get the card factory calibrated, should the user prove it to be out of specification. No manufacturer will reimburse the user for time and money wasted for bad data taken by a card that is out of calibration.

The reference is buffered, as Mr. Maclay states in his letter.

—Eric M. Miller

TAPE MEASURE

Your article entitled "Nine-track Tape Systems" (Roger Addelson, August 1986, p. 94) was a welcome look at a useful and often neglected storage medium for all computer systems, large and small. The review of products presented was, on the whole, fair and balanced. However, the copy of our tape software that was used for the review was a pre-release version. I would like to point out that the problems and limitations that were mentioned in the article do not apply to the tape package we are currently shipping.

Specifically, three items have been addressed. First, in the copy reviewed, the input field for giving the number of blocks to skip allowed for only two digits, limiting the skip count to 99. This field has been expanded, allowing as many as 32,767 tape marks to be skipped in one operation.

Second, the problem of leaving out the last block of a file when the block was short has been fixed. This problem occurred sporadically, depending on the particular addresses used within the tape write buffer.

Third, we have programming language interface modules to three languages—Microsoft C and COBOL and IBM Professional FORTRAN. These modules, which were omitted from the review copy of the product, provide 28 functions to application programs. With this array of functions, the programmer using any of these languages can exercise complete control over one or more nine-track tape drives.

Carl Chapman, vice-president
Flagstaff Engineering
Flagstaff, AZ

Thank you for including Innovative Data Technology's LEO PC subsystem in your "Nine-track Tape Systems" article. I would like to correct two statements made in your review of our package. First, our LEO tape controller supports 800-bpi NRZI in addition to the 1,600-, 3,200-, and 6,250-bpi densities mentioned, and is offered as a subsystem with our model TD1054 800/1,600-bpi transport. Secondly, and more importantly, Mr. Addelson used a preliminary version of our manual. He found our installation documentation to be "nonexistent." Although that *was* true, the subsystems now being shipped include a much more comprehensive manual with an expanded installation section.

In 1982, Innovative Data Technology was the first company to offer a one-half-inch, nine-track tape subsystem for the IBM PC. I appreciate Mr. Addelson's fine article calling attention to nine-track tape drives as a viable solution to complex micro-to-mainframe data interchange issues.

Michael L. Moore, vice-president
Innovative Data Technology
San Diego, CA

In response to Mr. Chapman and Mr. Moore, PC Tech Journal *always requests production copies of hardware and software for its product reviews. We accept, in good faith, the products and documentation that vendors send to our offices for review as just that.*

—WF

With regard to "Nine-track Tape Systems," I would like to correct information on two licensees of DataTrac products (Cipher Data Products and Catamount Corporation). Although Mr. Addelson's review of these products generally was favorable, his exclusion of them in network environments is curious. I believe that if he had tried these products in such an environment, he would have rated them superior in these applications as well.

The DataTrac products use a unique and proprietary method of accessing disk directory structure through the operating system during backup operations. This isolates our software from machine and operating system peculiarities and modified directory structures to which many, if not all, of the other systems you reviewed are vulnerable. This, coupled with full shared file support, leaves our product alone in its ability to operate with a broad variety of networks, Novell included. Our network support may not have been obvious to your author because it is virtually transparent. We think the verdict is not yet in on *the* dominant network of the future; certainly the field will include more than just Novell's product. (I recommend that you *try* the competition's network support with networks other than Novell. With our systems, if it is necessary to provide full system security by

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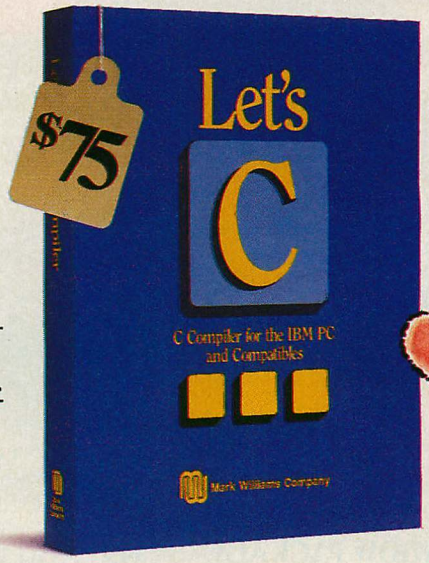

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backing up non-DOS files, this may be accomplished by including instructions in the batch stream that execute programs unique to the particular network that make DOS images of these files. The ordinary backup program then archives these images.)

In addition, your analysis seemed to cover primarily the common features of the equipment. Software such as our TDS software, which allows uploading and downloading of tape data directly to and from programs such as Lotus 1-2-3 and dBASE III, was not covered.

Your comparative tables were somewhat inaccurate and deceptive. The performance figures on page 102 are incorrect in several places (although I note that my licensees do well in this comparison). The table on page 99, in addition to the inaccuracy of the network support data, incorrectly represents the Flagstaff unit as providing "full tape label support." This support is, in fact, only cursory. ANSI labels contain much system-specific information that cannot be processed by Flagstaff's "full" support, yet is required by large systems if interchange using standard labeled tapes is to take place. (In fact, most large systems will not process foreign tape labels, ANSI standard or otherwise. ANSI standard labels have installation-specific dependencies as well.

Further, the author incorrectly implies that IBM labels are not ANSI labels, and that ANSI labels must be written in ASCII. This is simply not true. Most large systems that use ANSI labels do so in EBCDIC, whether the system was manufactured by IBM or not.) The word *full* should be reserved for more appropriate uses. Also on the subject of ANSI labeled tapes, your article implies that our systems cannot read ANSI labels or tapes that contain them. But they certainly can and do.

We have hundreds of satisfied customers using our systems in network environments and processing information from tapes written with ANSI (including IBM) labels.

Jay Sherritt, president
I.D.B. Corporation
Boulder, CO

As noted in the article, mainframe systems perform extensive tape label processing; DOS, for which tape is an infrequently used storage medium, does not. In this context, the Flagstaff Engineering subsystem was judged to provide full tape label support in that it reads, writes, and initializes labeled tapes.

Jay Sherritt is the author of A ½-inch Tape Primer *(originally published in 1984 and distributed with the company's products). In researching his article, Roger Addelson consulted this information on magnetic tape technology. A reference to this work should have been cited in the article.* PC Tech Journal *regrets the omission.*

—JS

MOST COMPATIBLE

Why have I wasted all my time on the "popular" PC press? I have written to all of them trying to get answers to my PC and PC/XT clone questions to no avail. Now I see that your magazine has addressed exactly what I have been looking for (except that it is for the PC/AT) in "Out from the Shadow of IBM" (Steven Armbrust, Ted Forgeron, and Paul Pierce, August 1986, p. 52).

The popular press seems to feel that its readers are satisfied with press releases from manufacturers, instead of actual reviews of compatibles. I suspect your readers are not.

My situation may be somewhat unique in that I plan to have two completely different applications—technical (aerospace structural engineering) and educational (in conjunction with home

instruction). It is my desire to develop commercial software in both areas. It would be ideal if the machine I purchased would be compatible both from the standpoint of software I would purchase and what I might produce. (Currently I choose not to buy an IBM PC.)

Please consider this encouragement to develop software to verify hardware compatibility *and* to publish hardware reviews of PC and PC/XT clones.

James O. Mayor
Damascus, MD

We're working on it. Thanks.

—WF

CHOICE CHIPS

I enjoy *PC Tech Journal* and often use what I read or see advertised in my work. But I think I should send a little information your way.

In his August 1986 Directions column, "Long Live the 286!" (p. 9), Will Fastie states that the only real solution to high-resolution, high-speed graphics is an adapter board with its own processor. I certainly agree. But then he goes on to mention only the Intel and TI graphics chips, available as samples and at very high prices.

What about the Hitachi 63484 ACRTC? It has been around for a year and a half, sells for $50, and has been available as a PC add-on since January, when we introduced the first DC1-4. The ACRTC, unlike the Intel chip, can drive truly high-resolution displays—up to 2,000 by 2,000 and more, and, unlike the TI chip, has graphics commands such as line, polygon, filled and unfilled rectangle, circle and ellipse, bitblt, paint, zoom, smooth pan, and scroll. And the most important point of all—it draws very, very fast.

Although I naturally think ours are the best PC graphics coprocessor boards that use the Hitachi chip, we are not alone. Keep up the good work. (On the question of 286 versus 386, I say let the people vote with their money. The marketplace has served us very well.)

Phillip Woellhof
Dolen Computer Corporation
Norwalk, CT

MINI PRAISE

I read with interest the review of Zebra Systems' MINI-PRINT in the May 1986 Product Watch (Tom Swan, p. 201). I bought a copy last September when the program was being advertised in *PC Tech Journal*. I since have been using it for most of my printing. I am writing to point out that the benefits of MINI-PRINT

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are not in its operation as a program, but rather in the output it produces. I use it primarily for printing program listings; the benefits include a major savings in time and frustration while reading and marking up programs. With MINI-PRINT, I use 380 lines per page rather than the normal 60, and find that I have less paper clutter in general.

David Forrester
Ann Arbor, MI

BACK TO BASICs

Some articles in *PC Tech Journal* have prompted me to wonder about your reviewers, notably Ted Mirecki's "Six New Shapes of BASIC" in the June 1986 issue (p. 52). On page 71, Mr. Mirecki presents timings that seem to show Professional BASIC from Morgan Computing as *slower* than BASICA (MULDIV, file copy, and graphics). When I performed floating-point benchmarks on Professional BASIC some time ago, I concluded that it was approximately seven times faster than BASICA.

The benchmark times in the table are so much at odds with my own experience that I have concluded Mr. Mirecki must have been using the wrong version of Professional BASIC. The product comes in an 8087 version, a version for 8088 only (much slower), and a BCD version for business applications (much slower still). I suspect that the BCD version was used here rather than the 8087. For benchmarks, it makes sense to use the best available version of each competitor, to let each take its best shot. Because the author does not reveal anywhere in the article which version he used, the foregoing is speculation. But it does explain how Mr. Mirecki produced such slow timings for such a fast product.

James F. Glass, partner
Advanced Systems Consultants
Chatsworth, CA

All benchmarks for all the BASIC products were run on an IBM PC2 with 640KB of memory, two floppy-disk drives, and no 8087. The 8088 version of Professional BASIC was used.

When comparing products with widely differing capabilities, the difficulty of choosing a common basis for the comparison is ever present. According to one school of thought, test conditions should be as similar as possible, while another approach is to use best-case conditions for each product. The configuration used for the tests was one that was thought to be typical, not necessarily optimal, for users of interpreted BASIC. After all, interpreters usually are chosen for their convenience, not for number-crunching speed.

—Ted Mirecki

MEDIA MOTIVATION

I am writing regarding Will Fastie's column in the June 1986 issue ("Bigger, Smaller, Faster, Slower," Directions, p. 11). Out here in the real world, data interchange between 3½-inch diskettes and 5¼-inch diskettes is a problem.

Our office shares about 100 diskettes per week among laptop users, geographical XTs, and centralized XT and AT configurations. Telecommunications costs prevent file transfer, so media exchange is our only option. We cannot afford to retrofit the existing PCs with new drives, nor can we simply discard the 1,200 diskettes in circulation.

The 5¼-inch diskettes will remain a reality until we cannot get new software in that format or until the existing equipment is depreciated. Has anyone considered that IBM changed formats *mainly* to sell more hardware and supplies? It worked in the mainframe world, and by the look of things, it will work in the micro world as well.

Wayne Socha
Los Angeles, CA

I did not mean to imply that data interchange problems did not exist, although in my travels I have not encountered many situations in which diskette data interchange is or is likely to be a significant problem. Where it is a problem, as in your case, the vendor (IBM) has options to deal with it.

Perhaps IBM did take the step to sell more hardware. However, I am glad the company is providing a de facto endorsement of the 3½-inch standard. IBM's interest in the media is important to its wider acceptance; the industry is long overdue in migrating to a compact and reliable media, not to mention its larger capacity.

—WF

ERRATA

Regarding "Software Sprites" (Michael Abrash and Dan Illowsky, August 1986, p. 125), the following corrections must be made to SPRITES2.ASM (listing 2) as it appears in the magazine: insert **jmp $+2** after line 185 (**out dx,al**); insert **assume ds:cesg** after line 196 (**pop ds ;restore data segment**); insert **jmp $+2** after line 352 (**out dx,al**); insert **jmp $+2** after line 463 (**out dx,al ;then enable vertical interrupt**). The correct listing is available on PCTECHline.

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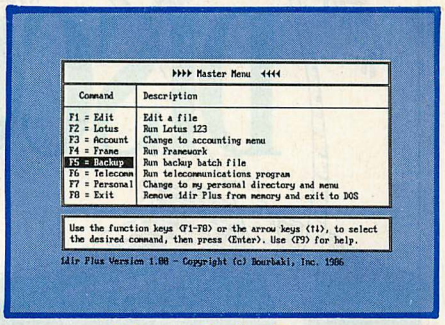
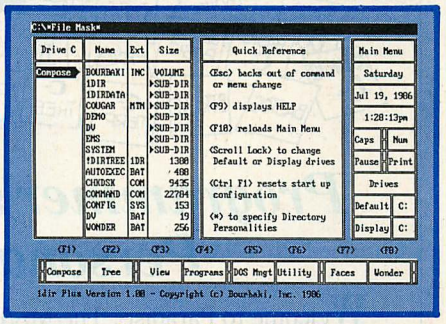
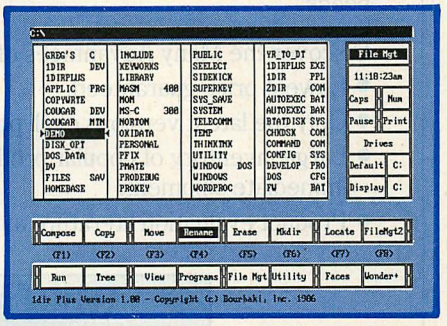


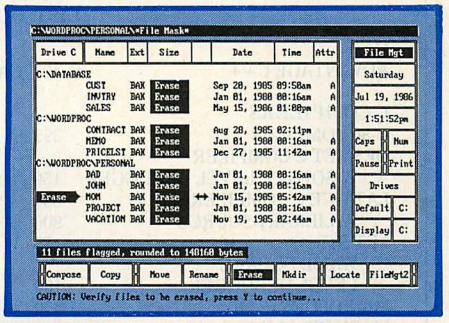
Menu Only Face



Quick Reference Face



Two Menu Face



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LATTICE C COMPILER	500	295
W/LIBRARY SOURCE	900	549
LET'S C	75	59
W/CSD SOURCE		
LEVEL DEBUGGER	150	115
MICROSOFT C 4.0	450	289
MARK WILLIAMS C	495	299
WIZARD C	450	369
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C-TERP	300	239
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META WINDOWS PLUS	235	199
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METAFONTS PLUS	235	139
MICROSOFT WINDOWS	99	69
MICROSOFT WINDOW DEV. SYS.	500	350
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SCREENPLAY (LATTICE C)	150	135
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TURBO PROLOG	100	79
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PANEL-BASIC	145	115
RM/BASIC	600	479
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COBOL COMPILERS/UTILITIES

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OPT-TECH SORT	149	119
REALIA COBOL	995	795
SCREENPLAY	175	155
RM/COBOL	950	675
RM/COBOL 8X	1250	995

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MICROSOFT C COMPILER v. 4.0—Latest version of the "... best MS-DOS C development environment value today."—Dr. Dobbs. Provides fast, optimized code. Version 4.0 includes Microsoft's new Codeview source-level windowing debugger.
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PASM 86	195	139
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POLYMAKE	99	79
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CSD SOURCE DEBUGGER	75	59
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RTRIEVE	85	79
BTRIEVE/N	595	465
XTRIEVE/N	395	299
RTRIEVE/N	175	159
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W/SOURCE	500	390
DB VISTA	195	159
W/SOURCE	495	429
INFORMIX	995	839
PHACT	295	265
QUERY	195	175
REPORT	165	149
PHACT W/SOURCE	995	845
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FORTRAN COMPILERS

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RM/FORTRAN	595	395

New Products

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FORTRAN UTILITIES

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	LIST	OURS
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Bundle of the Month

ADVANTAGE C++ and LATTICE C or MICROSOFT C—Take advantage of object-oriented programming with ADVANTAGE C++. Add resiliency and flexibility to your code without sacrificing the standardization of C. Build large and sophisticated programs more productively. This month's special bundle, buy Lattice C 3.1 or Microsoft C 4.0 together with ADVANTAGE C++ and save! List $945-$995 Ours **$775**

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FIRSTIME	245	199
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GSS GRAPHICS DEV. TOOLKIT	395	315
HALO	300	210
PANEL	295	189
PASCAL TOOLS I	125	105
PASCAL TOOLS II	100	84
SCREEN SCULPTOR	125	95
VIEW MANAGER	275	209

TOOLS FOR TURBO PASCAL

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HALO	300	219
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MICROSOFT LANGUAGES NEWSLETTER Vol. 1, No. 11

News about the Microsoft Language Family

Compiling Efficiently with Microsoft® QuickBASIC

Microsoft QuickBASIC Version 2.0 offers you a wide range of choices when you compile. You can compile programs directly into memory, or create executable programs on disk depending on your needs. To get the most out of the compiler, you should know the various size/speed tradeoffs associated with each compile option.

In-memory compilation places an executable file directly into memory from the Microsoft QuickBASIC programming environment. This is the easiest way to compile and run Microsoft QuickBASIC programs during program development. The advantage of this method is that it allows you to compile and run without leaving Microsoft QuickBASIC. However, the program can only be executed from inside the Microsoft QuickBASIC programming environment.

You can also use Microsoft QuickBASIC to create an executable file on disk that can be run without entering the programming environment. There are two different kinds of stand-alone executables: programs that include the run-time environment in the .EXE file and programs that require the presence of the run-time module BRUN20.EXE when run.

The .OBJ(BCOM.LIB) or /o option creates an object file that when linked to the BCOM20.LIB library becomes a program that runs without the presence of the run-time module BRUN20.EXE. Programs linked with the BCOM20.LIB are larger, but execute much faster than programs that require the run-time module. Besides execution speed, the advantages of this method are that the program does not require an additional file to run and the program can be conveniently copied to other disks.

The .OBJ(BRUN.LIB) option creates an object file that when linked to the BRUN20.LIB library requires the presence of the run-time module BRUN20.EXE to execute. Programs linked with BRUN20.LIB are smaller, but run slower than programs linked with BCOM20.LIB. The speed degradation results from the fact that BRUN20.LIB uses software interrupts to call the run-time routines, whereas BCOM20.LIB uses direct calls. The Speed or /q option explained below can minimize this difference. Depending on your size and speed requirements, you should probably link with BCOM20.LIB if you are distributing only one program, or if the user might copy the program to another disk without also copying the run-time module. If your application chains programs, or your distribution will include several programs, you should link with BRUN20.LIB and distribute BRUN20.EXE with your programs. There are no licensing requirements and no fee for distributing the BRUN20.EXE run-time module.

The .EXE option creates an executable program on the disk. This program requires the presence of BRUN20.EXE to execute.

The Debug or /d option should be used in debugging your program during development. It generates larger and slower code by including debugging and error handling code in the executable program that checks for arithmetic overflow/underflow, array bounds and the existence of GOSUBs with each RETURN statement. When the program is completely debugged and ready for distribution, you will want to compile the program without this option to maximize speed and minimize size.

You must use the On Error or /e option in programs that contain ON ERROR GOTO and RESUME *linenumber* statements. This option creates a larger program (by building a table of entries for each line number). Use the Resume Next or /x option in programs that contain RESUME, RESUME NEXT, and RESUME 0 statements. Compilation takes longer and results in larger object files than the On Error or /e option because it increases the table of line number entries.

The Checking Between Statements (/v) and Event Trapping (/w) options enable event trapping for communications, lightpen, joystick, timer and function keys. Both of these options increase code size and slow execution. The Event Trapping (/w) option checks between lines for the occurrence of an event and takes less space and execution time than /v.

The Speed or /q option optimizes the programs compiled using BRUN20.LIB to be nearly as fast as programs compiled using BCOM20.LIB, but results in a larger executable because every call has two bytes more overhead. If you do not specify this option, the program will be as small as possible but the execution speed is slower than if you specified /q. The size and speed effects of this option depend on the number of repeated statements in loops you use in your program.

If you are compiling in memory and you are getting "Out of Memory" errors, you may want to use the Minimize String Data or /s option. This option writes quoted strings to the .OBJ file instead of the symbol table. This allows you to compile a large, string-intensive program without getting "Out of Memory" errors when compiling in memory, but it increases the size of the .OBJ file. De-selecting the Debug option may also solve out of memory problems in large programs.

For more information on the products and features discussed in the Newsletter,
write to: Microsoft Languages Newsletter
16011 NE 36th Way, Box 97017, Redmond, WA 98073-9717
Or phone:
(800) 426-9400. In Washington State and Alaska,
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Latest DOS Versions:	
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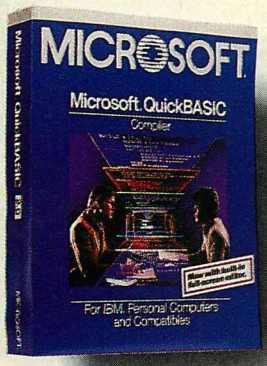


A Basic Improvement

Offering a natural extension to a built-in language, Microsoft's QuickBASIC 2.0 improves on the standard of quality that was set by Turbo Pascal.

The arrival of Borland International's Turbo Pascal (see "Turbo Pascal," Product of the Month, January 1985, p. 187) was an important milestone for commercial software. Never before had a programming language for the IBM PC cost so little and performed so well.

The combination of Turbo Pascal's price and quality set a standard by educating thousands of users to expect more from software products. Even that, however, was not enough to launch Turbo Pascal. One important characteristic immediately set Turbo apart and forever changed the way many of us think about software: the integration of a language into an environment containing an editor along with all of the other tools needed to create stand-alone, executable versions of an application. The editor is particularly helpful because the system is able to detect compilation errors and immediately place the user in the editor at the point of the source code misstep.

The Turbo Pascal environment proved so popular that speculation soon turned to the language that would get the Borland treatment next. Rumors abounded that it would be C or BASIC, but Borland surprised everyone with Turbo Prolog. (Turbo Prolog is reviewed in this issue in "Prolog Advances," Michael Covington and Andre Vellino, p. 52.)

Borland may have lost a major opportunity by turning to Prolog rather than a more widely used language. Attention most certainly will be focused now on another vendor of languages—Microsoft, whose newest release of QuickBASIC earns *PC Tech Journal's* approval as Product of the Month for November 1986.

Duplicating Borland's success with another language is certainly not enough to get our attention. Microsoft has used the concepts embodied in Turbo Pascal but, to its credit, has gone much beyond them.

Microsoft has implemented its bread-and-butter product in an entirely new form. This is not to be taken lightly. No matter how great the popularity of Turbo Pascal: BASIC continues to be one of the simplest languages to learn and use, especially for small programs, and the large audience of PC users will certainly appreciate this natural extension to the language that comes already built-in to their computers.

QuickBASIC 2.0 (QB2) accepts almost every bit of IBM BASIC (BASICA) syntax (with a few exceptions), and most programs should run with little or no fiddling. The most likely problem users will encounter is the absence of array declarations, or array definitions found by the compiler after references have been detected and flagged as errors. Array dimensioning problems are not much of a hurdle to jump.

A major improvement of QB2 over Turbo Pascal is the editor. As much as the integration of the editor suited just about everyone, Borland's choice of WordStar-like control sequences and limited function forced most serious programmers out to their favorite text editor, thus reducing the built-in editor to quick-fix syntax repairs. The QB2 editor, on the other hand, is quite functional. Microsoft did a particularly nice job in making most of the line editing features of BASICA available while at the same time building a reasonable, full-screen editor.

Editing is enhanced further with a mouse, although QB2 works smoothly from the keyboard as well. QB2 is implemented with *text windows*, which are functionally identical to Microsoft's Windows product but without graphics capability. This means that the editor has scroll bars for moving through the text as well as pull-down menus.

The feature that sets QB2 apart is its compile operation. Instead of stopping on every error and bouncing to the editor, QB2 collects all errors and allows the user to position to each error site in turn. The user can edit the source at each error or not, as required or desired. In practice, this method of error correction is much faster than the repetitive compile-edit cycle that corrects, at most, one error per cycle.

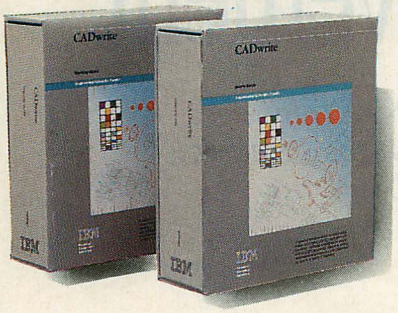
QB2 makes significant enhancements to the language and has many extra features in the compiler's environment. It allows alphanumeric labels, makes line numbers optional, extends IF...THEN...ELSE statements with multiline blocks, and improves subroutines with names, arguments, and local/global variables. If the BASIC program grows too large, QB2 can compile source modules into .OBJ form, from which they can be linked in the traditional way. The most important extra feature is probably the debugger, which is triggered by the familiar TRON and TROFF statements. Once activated, the debugger can single-step or trace through the program, allowing the user to see the executing source line on the screen as the program proceeds.

Perhaps the most ringing endorsement of QB2, however, is less technical. This writer has completely abandoned the fully interactive BASICA in favor of the QB2 environment and uses the built-in editor instead of his long-standing favorite text editor.

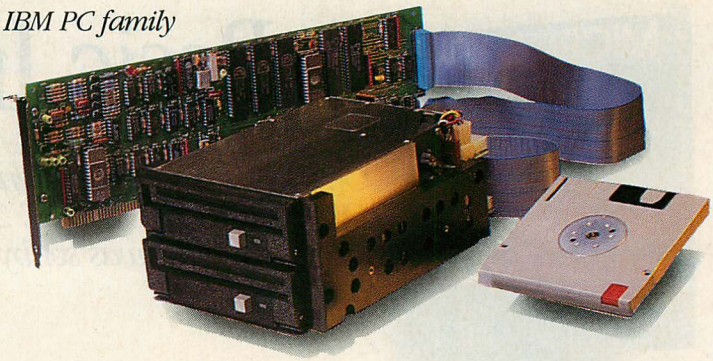
QuickBASIC 2.0 has performance, style, and substance. It is a clean, carefully thought-out implementation. And, it is probably a harbinger of things to come. Microsoft has the technical expertise as well as the financial resources to bring this technology to other languages. It most surely will.

QuickBASIC 2.0: $99
Microsoft Corporation
16011 Northeast 36th Way
P.O. Box 97017
Redmond, WA 98073-9717
800/426-9400; 206/882-8080
CIRCLE 348 ON READER SERVICE CARD

Hardware, software, and other developments for the IBM PC family



CADwrite from IBM



Sysgen's DuraPak Winchester subsystem

FROM IBM

A multifunction **Memory Expansion Adapter** for the PC/AT has been announced by **IBM Corporation**. Memory is expandable to 3MB with snap-on memory modules. The board has a split memory addressing capability that allows memory to be added to both the base system and extended memory area (beyond 1MB) of the AT. It includes a parallel printer port and an asynchronous serial communications port. $595; 512KB Memory Module Kit, $165.
IBM Corporation, 100 Summit Avenue, Montvale, NJ 07645; Contact the local IBM dealer, 800/426-2468

CIRCLE 301 ON READER SERVICE CARD

IBM Information Systems Group has announced **PC/VTXACCESS**. This program allows the user to view and optionally capture NAPLPS (North American Presentation Level Protocol Syntax) or ASCII videotex information interactively with a videotex host, or to retrieve previously captured videotex information from local files. PC/VTXACCESS provides a directory service screen that permits a user to define as many as 10 services that may be local or at a remote host. The program supports various file operations, including downloading NAPLPS frames or ASCII files from a host to the PC and sending NAPLPS frames or ASCII frames from one PC to another. Locally stored NAPLPS frames or ASCII files can be viewed one at a time or can be rolled in a timed sequence. $65.
IBM Corporation, Dept. 6CS, 10401 Fernwood Road, Bethesda, MD 20817; Contact the local IBM dealer; 800/426-2468

CIRCLE 302 ON READER SERVICE CARD

IBM also has announced **CADwrite**, a full-function, two-dimensional CADD application that includes a semiautomatic isometric construction function. A 15-lesson, self-paced training guide and on-screen prompts direct the user through each action required. CADwrite runs on the PC, PC/XT, and PC/AT, and IBM 5531, 7531, and 7532 Industrial Computers with more than 512KB of memory and a minimum 10MB fixed storage. CADwrite supports the Enhanced Graphics Adapter, Enhanced Graphics Display, Personal Color Display, Monochrome Display, Professional Graphics Controller, and Professional Graphics Display. $1,995.
IBM Industry Systems Products, CADwrite Order Department, P.O. Box 3025, Building 234-1/4328, Boca Raton, FL 33432; Contact the local IBM dealer, 800/426-2468

CIRCLE 303 ON READER SERVICE CARD

HARDWARE

DuraPak, an internal Winchester subsystem from **Sysgen Incorporated**, features removable hard-disk cartridges. DuraPak is available as either a single-drive 15MB or dual-drive 30MB system; both include a bootable controller and installation hardware. The DuraPak 15MB cartridge measures 4.25 by 4.37 inches. DuraPak single-drive version, $1,295; dual-drive, $2,095.
Sysgen Incorporated, 47853 Warm Spring Blvd., Fremont, CA 94539; 415/490-6770

CIRCLE 307 ON READER SERVICE CARD

A PC/AT-compatible ROM BIOS for the Intel 80386 microprocessor is available from **Phoenix Technologies Ltd.** The **80386 ROM BIOS** includes extended CPU diagnostics, full 32-bit memory testing, support for the 80387 numeric coprocessor, and support for processing speeds as high as 20 MHz. It takes advantage of the 80386 architecture to enhance the BIOS-related function of switching between real and protected modes, when used for such tasks as virtual disk or overlay management.
Phoenix Technologies Ltd., 320 Norwood Park S, Norwood, MA 02062; 617/769-7020

CIRCLE 304 ON READER SERVICE CARD

Crosspoint Systems has introduced its first line of software-controlled data switches. The **Crosspoint 8** allows any combination of eight PCs or peripherals to be connected for sharing or adding peripheral devices. The **Crosspoint**

Crosspoint 8 by Crosspoint Systems

AB+ allows a PC to recognize as many as seven more peripherals in addition to those that are connected to the PC's standard serial and parallel ports. Both products use pop-up menus to configure as many as 16 standard applications for each PC. Software configuration of the switches allows the user to customize settings for use with specific peripherals, modems, or computers, and allows any combination of devices to be connected to PCs, printers, plotters, modems, and host computers. Crosspoint 8, $795; Crosspoint AB+, $495.
Crosspoint Systems, 1170 Willow Creek Circle, Eugene, OR 97402; 800/232-7729; in Oregon, 503/485-4254

CIRCLE 315 ON READER SERVICE CARD

Digital Communications Associates, Inc. (DCA) has introduced the **IRMALAN** line of products, bringing IRMA functionality and mainframe APA (all-points-addressable) graphics capabilities to PCs

Nth Graphics' Nth Engine with 19-inch monitor

Cambridge Computer Graphics' 20-inch display

on an IBM Token-Ring Network or other NETBIOS-compatible LANs.

The **IRMALAN SNA Workstation** program emulates an IBM 3278 display station model 2, 3, or 4 or an IBM 3287 printer. A hot-key feature lets the user switch among five concurrent host sessions or allows switching between DOS and terminal emulation. $495.

The **IRMALAN APA Graphics Workstation** program adds APA graphic capabilities to the features of the SNA Workstation. $995.

A hardware/software product, the **IRMALAN SDLC Gateway** allows a PC on the LAN to emulate an IBM 3274/76 terminal control unit (TCU). This permits any LAN equipped with IRMALAN SNA or APA Graphics Workstation software remote access to an IBM mainframe via the SDLC Gateway. $1,195.

Another hardware/software product, the **IRMALAN DFT Gateway**, allows PC workstations that are equipped with the IRMALAN software to share a coaxial connection to an IBM 3274 TCU operating in DFT (distributed function terminal) mode. $1,195.

A line of graphics products also has been released. The **IRMA 3279 Graphics**, an IBM 3279 color graphics emulator, provides PCs and true compatibles with 3279 S3G PS (programmed symbol) mainframe color graphics in any IBM 3270 processing environment. $1,995; upgrade board, $1,195.

The **IRMAX APA Graphics** brings mainframe APA color graphics to PC users within a DFT-configured controller environment. $1,595; upgrade, $795.

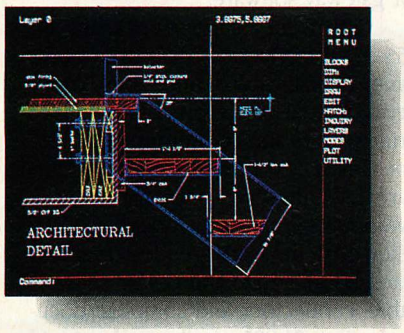
IRMAcom APA Graphics is an IBM 3274 controller and a 3270 display emulator that enables a remote PC to be provided with mainframe APA color graphics capabilities. $1,295.

IRMAX Multisessions, a DCA hardware/software package, uses DFT technology to give the user simultaneous access to four host applications. The windowing environment allows the application windows to be manipulated, altered in size up to a full screen, zoomed, and hidden from view via simple keystrokes. $1,495; upgrade board, $495.

Digital Communications Associates, Inc., 1000 Alderman Drive, Alpharetta, GA 30201-4199; 800/241-IRMA, ext.700 or 404/442-4000

CIRCLE 305 ON READER SERVICE CARD

A high-performance, high-resolution, full-color graphics board set for the PC/AT and RT/PC has been announced by **Matrox Electronic Systems, Ltd.** The **PG-1280** is a 1,280-by-1,024 color graphics board set that is 100-percent plug compatible with the IBM Professional Graphics Controller, Color Graphics Adapter, and the VDI (virtual device interface). The PG-1280, with a high-resolution monitor, can draw 20,000 vectors per second, 15,000 characters per second, and BITBLT at 13 million pixels per second. The PG-1280 has commands for operations such as stroke text and double buffering. $3,995.



AutoCAD screen—display driven by Matrox PG-1280

Matrox Electronics Systems, 1055 St. Regis Blvd., Dorval, Quebec, Canada H9P 2T4; 800/361-4903; in Canada, 514/685-2630

CIRCLE 308 ON READER SERVICE CARD

A 1,024-by-768-resolution color display for the PC/XT, PC/AT, RT/PC, and compatibles has been introduced by **Cambridge Computer Graphics**. The **20-inch display** was developed for designs and drawings—such as mechanical design, printed circuit boards, and architectural layouts—that require several layers of information. It can display 16 colors or shades from a palette of 262,000 and has a drawing speed of 900,000 pixels per second. $4,995; 256-color version, $5,495.

Also from Cambridge comes the **Hilite display system**, with eight shades of gray. It is a 20-inch monitor with 1,024-by-768 resolution, a 72-Hz noninterfaced refresh rate, and graphics controller card with more than 30 graphics subroutines in ROM. $2,995.

Cambridge Computer Graphics, 6201 Ascot Drive, Oakland, CA 94611; 415/530-4148

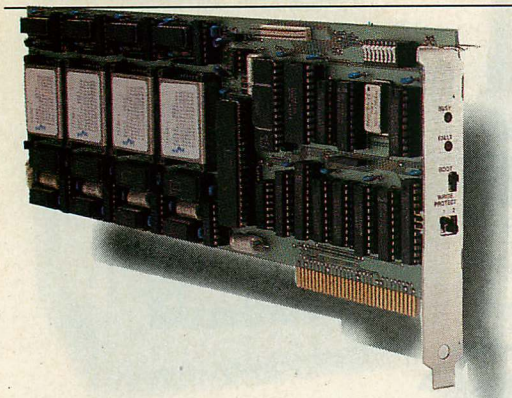
CIRCLE 316 ON READER SERVICE CARD

A graphics display controller, the **Nth Engine**, has been introduced by **Nth Graphics, Ltd.** The Nth Engine increases the speed of a PC-based CAD system by a factor of more than 200. It uses two powerful microprocessors, a Custom Graphics Engine and the Hitachi ACRTC graphics processor, and 2MB of on-board RAM in a configuration that results in sustained processing speeds of more than 25,000 vectors and more than one million pixels per second. The controller produces a flicker-free (noninterlaced) display resolution of 1,024-by-768 pixels with as many as 16 colors that may be selected from a palette of 4,096. A windowing feature permits multiple views of a drawing on the screen simultaneously, as well as switching among views as if turning the pages of a book. $3,995.

Nth Graphics, Ltd., 1807-C W. Braker Lane, Austin, TX 78758; 800/624-7552; in Texas, 512/832-1944

CIRCLE 318 ON READER SERVICE CARD

A combination high-speed synchronous modem and SDLC (synchronous data link control) communications adapter



PCI-1 BUBBL-BOARD from Bubbl-Tec

LOGITECH's LOGIMOUSE C7 with supported software

for the IBM PC family has been introduced by **Network Software Associates, Inc.** The **AdaptModem 4800** comes with Automatic Call Control software that features auto-dial, auto-answer, auto-redial, a 180-entry call directory for speed dialing or automatic unattended operation, automatic telephone line, and modem testing procedures, plus modem configuration options. AdaptModem 4800 can be used in either PC-to-host SNA networks or in PC-to-PC communications. $1,195; AdaptModem 2400, $795.
Network Software Associates, Inc., 22982 Mill Creek, Laguna Hills, CA 92653; 714/768-4013
CIRCLE 306 ON READER SERVICE CARD

LOGIMOUSE C7, a CMOS mouse from **LOGITECH, Inc.**, draws a maximum of five milliAmperes of current and, consequently, does not require an external power supply. LOGIMOUSE C7 offers a standard 200-dpi (dots per inch) resolution with 320 dpi available, and a maximum programmable baud rate of 9600. Connector options include a 25-pin RS-232 connector for the PC, a 9-pin serial connector for the PC/AT, and custom connectors upon request. $99; with software that customizes the mouse for various popular business, graphics, and CAD applications, $119.
LOGITECH, Inc., 805 Veterans Blvd., Redwood City, CA 94063; 415/365-9852
CIRCLE 319 ON READER SERVICE CARD

A 4800-bps synchronous modem with a multiprotocol autodialer has been introduced by **Racal-Vadic**. The compact **4850PA** provides Bell 208 and CCITT V.27 compatibility, four integral automatic dialers, and full front-panel control; it can be upgraded to 9600 bps. The integral automatic dialer supports 801-type parallel automatic calling and 3270 SDLC, HDLC, and 3780 BiSync serial dialing protocols. The 4850PA's dialing and command protocol is modeled around the CCITT V.25 bisynchronous recommendation for synchronous automatic dialing. $1,295.
Racal-Vadic, 1525 McCarthy Blvd., Milpitas, CA 95035; 800/4-VADICS; in California, 408/946-2227
CIRCLE 309 ON READER SERVICE CARD

An enhanced version of the G/NET LAN from **Gateway Communications, Inc.** has become available. **G/NET PLUS** features a built-in high-speed Local Bridge and the company's Gateway Network Access Method. The Local Bridge allows extension of the network beyond its rated maximum length, as well as the clustering of subnetworks for departmental office environments. GNAM software is a session-level transfer protocol that provides "hooks" to the network for gateway software.

G/NET PLUS supports as many as 255 PCs, PC/XTs, or PC/ATs over a baseband, coaxial-cabled, linear-bus-based network. It also supports multiple file/print servers and communication servers. G/NET accommodates several third-party LAN file server software systems. A two-node starter kit includes two LNIMs, a key card, the NetWare file-server software, Local Bridge and GNAM software, cable, connectors, and complete documentation, $1,895; similar package with Advanced NetWare, $1,995.
Gateway Communications, Inc., 2941 Alton Avenue, Irvine, CA 92714; 800/367-6555; in California, 714/553-1555
CIRCLE 310 ON READER SERVICE CARD

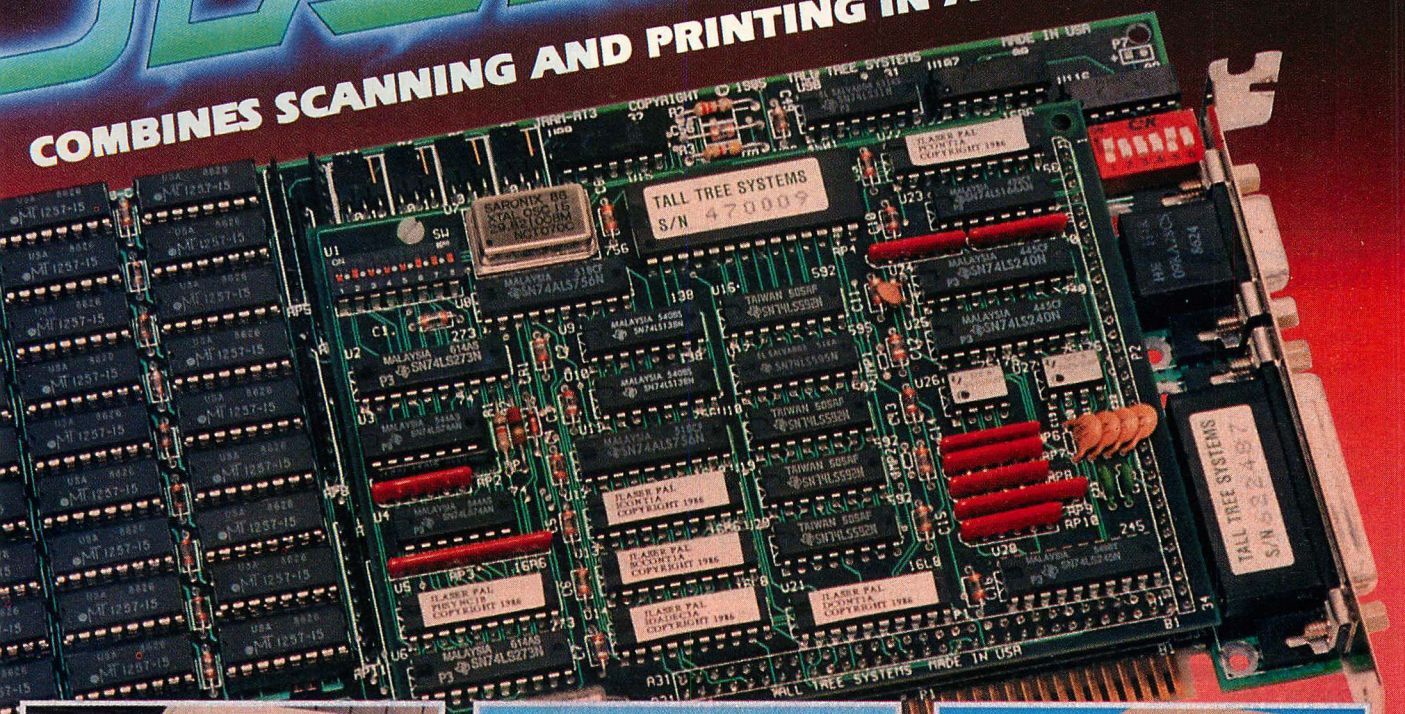
Data Technology Corporation has announced a **disk drive** that combines Winchester capacity and speed with the expandability of flexible data storage. The subsystem features 10MB flexible media cartridges in a 5¼-inch format. The technology, developed jointly by Data Technology and Eastman Kodak, is based on a fast-coil actuator that replaces the slower stepper motor used in conventional flexible or Winchester disk drives. This allows 333 tracks per inch radial density and an average access time of 75 milliseconds. The hard jacket of the flexible magnetic media and the embedded servo-pattern of the drive increases the reliability of the media (up to 10 million passes) and its interchangeability from drive to drive. Half-height drive, $1,195; dual configuration, $1,995; diskette cartridge, $39.
Data Technology Corporation, 2775 Northwestern Parkway, Santa Clara, CA 95051; 408/496-0434
CIRCLE 311 ON READER SERVICE CARD

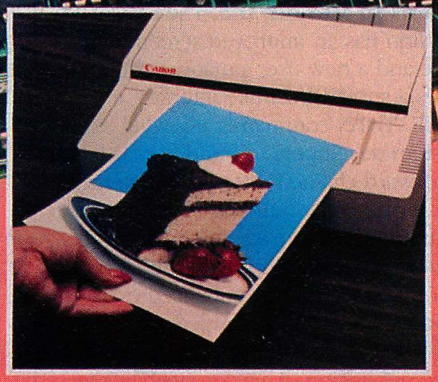
The **Bubbl-Tec** division of **PC/M, Inc.** offers a magnetic bubble mass-storage systems for the IBM PC family. The **PCI-1 BUBBL-BOARD** provides 512KB of magnetic bubble memory on a single PC adapter card and allows PC-based systems to use solid-state mass storage in applications where electromechanical media, such as disk and tape, are unsuitable. The average access time is under 30 milliseconds, and the effective data transfer rate to or from the bubble devices exceeds 260Kbps. The system requires only 5- and 12-volt power, derived from the PC bus. 512KB PCI-1, $1,111 in quantities of 10.
Bubbl-Tec, 6805 Sierra Court, Dublin, CA 94568; 415/829-8700
CIRCLE 322 ON READER SERVICE CARD

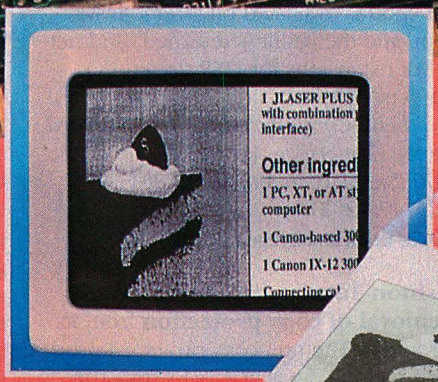
Advanced Logic Research, Inc. has released the **PC2/286**, an 80286-based, 8-MHz PC system. The basic system includes 512KB RAM (expandable to 1MB on the system board), 1.2MB floppy-disk drive and controller, monographics adapter, high-resolution monochrome monitor, parallel printer port, serial port, five expansion slots (two PC/AT and three PC), and an AT-style 83 key-board with LED status lights. $1,545.
Advanced Logic Research, Inc., 10 Chrysler, Irvine, CA 92718; 714/581-6770
CIRCLE 371 ON READER SERVICE CARD

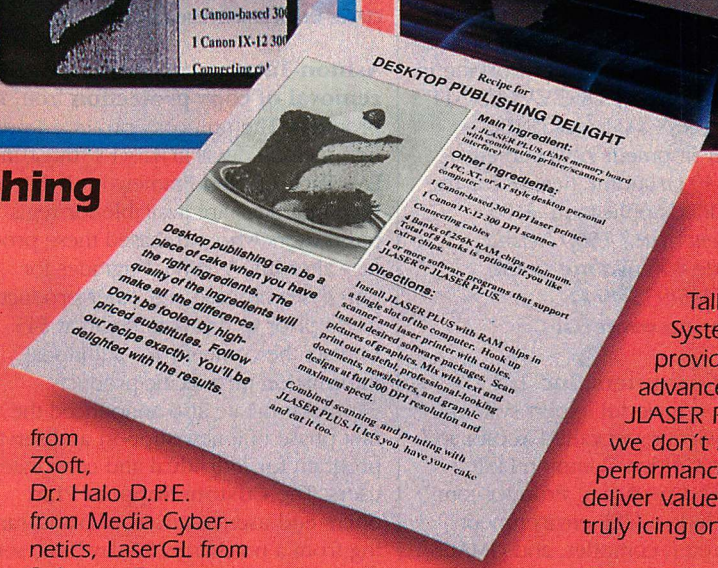
JLASER PLUS

COMBINES SCANNING AND PRINTING IN A SINGLE BOARD!









It makes desktop publishing a piece of cake!

Tall Tree Systems introduces another breakthrough in desktop publishing with JLASER PLUS. We've combined a 2 MB EMS memory board and an interface to both a Canon®-based laser printer and scanner. JLASER PLUS increases the performance of both devices and gives you a low-cost solution to the limitations you've been experiencing with them.

Furthermore, the same memory that is made available to your printer and scanner is also available for all your other conventional applications. You get system memory, expanded LIM memory, extended memory in an AT-type machine, RAM Disk and print spooler — all in a single slot!

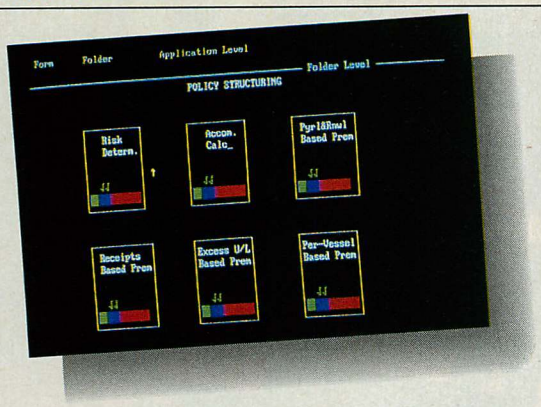
Supporting JLASER PLUS is a host of software packages, such as PC Paintbrush + from ZSoft, Dr. Halo D.P.E. from Media Cybernetics, LaserGL from Software Express, Ventura Publisher from Xerox, Page Builder from White Sciences, Le Print from Le Baugh Software, Fancy Font and Fancy Word from SoftCraft, Inc., and many more to be announced.

It takes a technological innovator like Tall Tree Systems to provide a major advancement like JLASER PLUS. And we don't stop at performance. We also deliver value, which is truly icing on the cake.

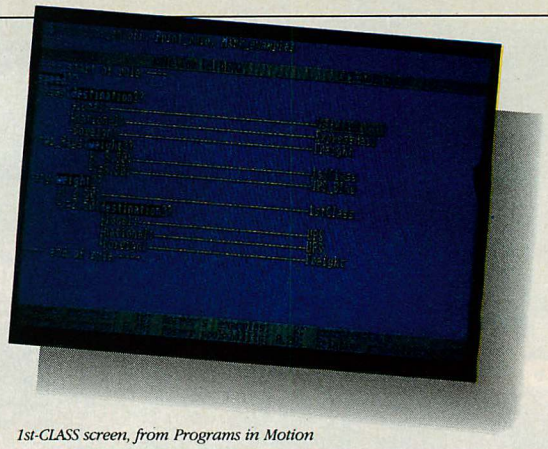
TALL TREE SYSTEMS
1120 San Antonio Road
Palo Alto, CA 94303
(415) 964-1980

CIRCLE NO. 194 ON READER SERVICE CARD

TALL TREE SYSTEMS



Screen from Gold Hill's ACORN



1st-CLASS screen, from Programs in Motion

Arnet Corporation has introduced **Twinport**, a serial port board for connecting terminals, printers and other devices to multiuser PC systems. Twinport adds two RS-232 serial ports to the PC, PC/XT, or PC/AT, and works with XENIX, Pick, Theos, BOS, and other multiuser operating systems. Board, $269; parallel printer port, $29; clock/calendar, $89; DOS driver, $25.
Arnet Corporation, 476 Woodycrest Avenue, Nashville, TN 37210; 615/254-0646

CIRCLE 312 ON READER SERVICE CARD

SOFTWARE

Virtual Systems, Inc. has introduced its **APEX/86** realtime executive for Intel's iAPX86 (8086/88 and 80186/188) family of microprocessors. APEX/86 supports development of realtime process control, data acquisition, and data communications software. It allows iAPX86-based embedded applications to be constructed by system engineers working in either the PC DOS or DEC VAX/PDP-11 (VMS, RT-11, RSX-11M, and UNIX/ULTRIX) development environments. License, $2,400; runtime license for use with embedded application, $100.
Virtual Systems, Inc., 1500 Newell Avenue, Suite 406, Walnut Creek, CA 94596; 415/935-4944

CIRCLE 327 ON READER SERVICE CARD

Gold Hill Computers, Inc. has announced a powerful expert system building environment called **ACORN** and based on its Golden Common LISP (GCLISP) 286 Developer. Product components include a LISP environment with interpreter, compiler, and GMACS editor; inference engine, knowledge representation language, graphics module, interface building facilities, and browser; expert system tutorial that serves as an on-line help system; and system documentation with quick reference guide. Technical features include integrated forward and backward chaining, frame-based knowledge representation, power screen generation, mouse support, hooks to PC tools certainty factors, and explanation facility. $5,000.

Engineering workstations, minicomputers, mainframes, and LISP machines that support the TAP/IP protocol can communicate with PCs through Gold Hill's **Golden Common LISP Network TCP/IP**. Features include file transfer, remote terminal log-in, and electronic mail. The network also facilitates lower-level applications development along with remote evaluation (a function is evaluated on a remote system, and the result is returned) and network extensions for LISP stream I/O. $495 per network node.
Gold Hill Computers, Inc., 163 Harvard Street, Cambridge, MA 02139; 800/242-LISP; in Massachusetts, 617/492-2071

CIRCLE 326 ON READER SERVICE CARD

Ashton-Tate has announced the **removal of copy protection** from its products. The non-copy-protected products include dBASE III PLUS 1.1, dBASE III LAN Pack 1.1, and Framework II 1.1. Free upgrades are available for registered users who purchased these products after July 5, 1986. Upgrades for purchases of these and other products made prior to that date begin at $45. Contact the company for additional information on specific products.

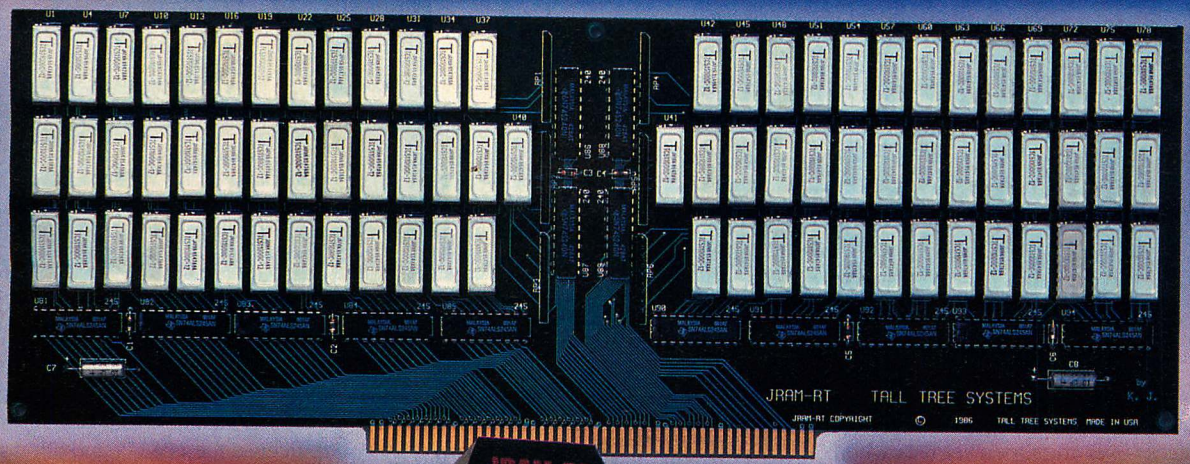
Ashton-Tate also announced the first phase of a new support and service program for individual and corporate users. The **Custom Support Plan** offers end users a variety of plans, ranging from a no-charge, 90-day basic service to a professional-level service for $150 annually. The plans offer a fixed number of telephone calls, plus support such as discounts on Ashton-Tate publications, a utility disk, Norton-Lambert's Close-Up remote debugging service, and so on. The **Corporate Support and Services Program** provides a dedicated service representative, a toll-free telephone number for technical support, the opportunity to preview new products, and discounts on publications and seminars. Annual fee, $4,000; additional sites, $2,000 each.
Ashton-Tate, 20101 Hamilton Avenue, Torrance, CA 90502-1319; 800/2-ASHTON; in California, 213/329-8000

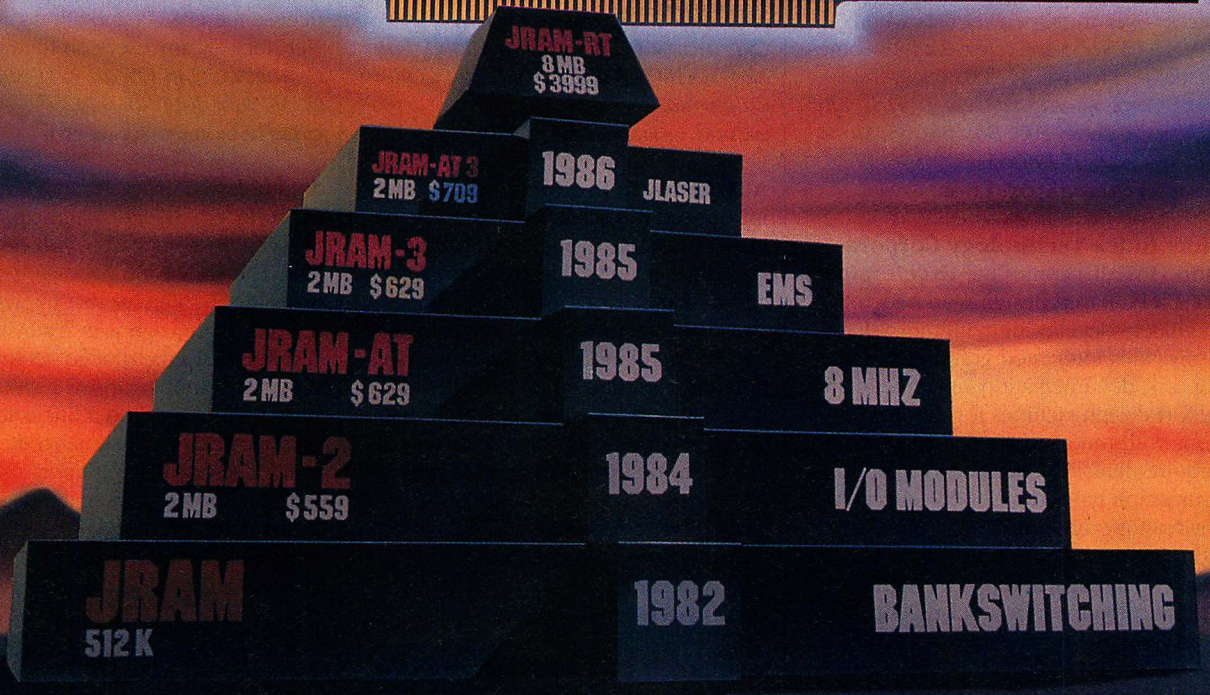
CIRCLE 329 ON READER SERVICE CARD

Version 3.0 of the expert system tool **1st-CLASS** has been released by **Programs In Motion, Inc.** The enhanced version has an improved screen interface and a new user's manual. 1st-CLASS uses a spreadsheet-like interface instead of IF...THEN commands, allowing expert system developers to build forward- and backward-chained systems by entering examples or by building rules on a graphic decision tree. Features include global variables, improved report generation, a trace facility, enhanced explanation facilities, and expanded rule capacity. The company authorizes royalty-free publishing of any knowledge base developed with 1st CLASS. $495.
Programs In Motion, Inc., 10 Sycamore Road, Wayland, MA 01778; 617/653-5093

CIRCLE 332 ON READER SERVICE CARD

Intel Corporation has announced **release 7.0** of its **iRMX86** realtime, multitasking operating system. New features include an ICU (interactive configuration utility) screen for incorporating device drivers with multibus I peripheral controller boards, terminal support code that enables a lock mode terminal to transmit an entire block of data with a single keystroke, system call external declaration files for Pascal-based and FORTRAN-based programs, a dynamic log-on feature, and an extended I/O system buffering enhancement. Release





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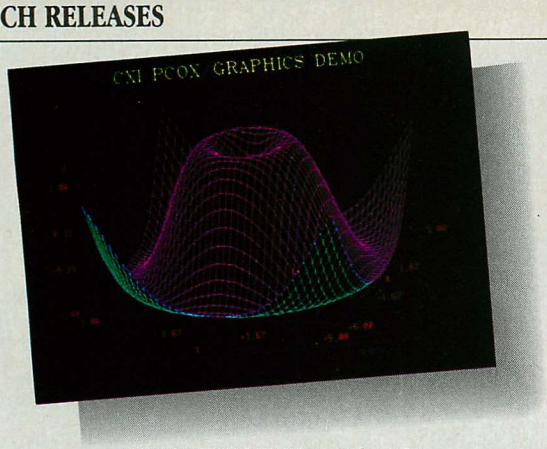


PCOX/GRAPHICS-3270 PC screen, from CXI

MultiLink Advanced by The Software Link

7.0 of iRMX86 will support remote file access over the OpenNet LAN when iRMX-NET software release 2.0 becomes available. License, $6,000.
Intel Corp., Literature Dept. W313, 3065 Bowers Avenue, P.O. Box 58065, Santa Clara, CA 95052-8065; 800/548-4725
CIRCLE 328 ON READER SERVICE CARD

From **Index Technology Corporation** (InTech) comes the **Excelerator/RTS**, a PC-based design workbench for engineers developing realtime systems. It provides integrated graphics, analyses, reports, documentation, and screen and report design facilities for designing systems with time and control processing requirements. Excelerator/RTS supports four graph types developed especially for realtime systems design: transformation graphs, state transition diagrams, matrix diagrams, and block diagrams. The Excelerator/RTS supports both the Ward and Mellor and the Hatley realtime system design techniques. $8,400.
Index Technology Corporation, 101 Main Street, Cambridge, MA 02142; 617/491-2100
CIRCLE 330 ON READER SERVICE CARD

From **CXI, Inc.** comes **PCOX/GRAPHICS 3270-PC**, a micro-to-mainframe graphics software product that combines IBM 3279 model S3G emulation and 3270-PC emulation. The software operates with the PCOX/GRAPHICS connection to enable the PCs to concurrently access one mainframe graphics session, in addition to four other host sessions, one PC session, and two notepads. Thus, users can combine information from multiple alphanumeric and graphics sources on one screen, and eliminate the need to frequently log on and log off sessions. In addition, any of the host sessions can be used as a printer session, allowing PC-attached printers to act like 3287 host-addressable printers. The product emulates 3278 models 2, 3, 4, and 5; 3279 models 2A, 2B, 3A, and 3B; and S3G terminals. Seven-color support is provided. $395; graphics board, $1,995.
CXI, Inc., 3606 W. Bayshore Road, Palo Alto, CA 94303-4229; 800/225-PCOX; in California, 415/424-0700
CIRCLE 334 ON READER SERVICE CARD

ACE Software Products, Inc. has introduced the **SCREEN-ACE Form Master** for APL, C, and assembly language. SCREEN-ACE is designed to create and maintain forms, tables, text screens, and menus, thus enabling the programmer to spend more time on the application and less time on creating the user interface. It is based on assembly language programs that allow the PC's display to be treated as a series of fields instead of individual characters. $195.
ACE Software Products, Inc., 6934 Petit Avenue, Van Nuys, CA 91406; 818/989-5329
CIRCLE 331 ON READER SERVICE CARD

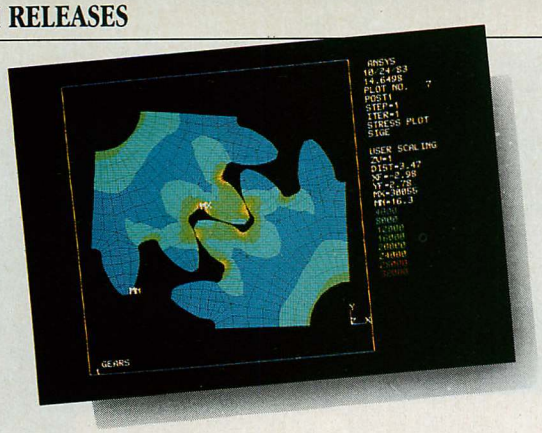
SKYLIGHTS, a software prototyping and development package from **Skylight Software, Inc.**, is a comprehensive set of tools using the prototyping approach. SKYLIGHTS consists of a screen/window/menu editor, runtime libraries of windowing, menu-handling, and front-end support routines, and a demo/tutorial program. Included is Screen Grabber, a utility for importing screens from other programs for interactive analysis and prototyping of the user interface. $395.
Skylight Software, Inc., 2 Charles Street, Bedford, MA 01730; 617/275-2999
CIRCLE 333 ON READER SERVICE CARD

A software utility from **Connectec** enables LAN users to retrieve a consistent time and date from any MS-NET or PC-NET file server. **NetClock** improves the integrity of directory dates by synchronizing clocks during network start-up. Network security is improved with consistent and accurate logging of user activity. NetClock is not memory resident and uses no RAM space on the file server or the users' PCs. A two-server license fee is $275 and allows access to NetClock by any users on the network.
Connectec, 333 Cobalt Way, Sunnyvale, CA 94086; 408/245-3492
CIRCLE 335 ON READER SERVICE CARD

A complete C programming environment for embedded system application is available from **Systems & Software, Inc.** The **REX-C/86** package includes an 8086/186 C compiler that implements the full C language with extensions compatible to the drafted ANSI C standard. The compiler provides ROMable code generation, and a linker/locator package and hexadecimal code convertors for PROM programming using either the Intel or the extended Tektronix code. REX-C/86 end-user license, $750; site license, $9,500.
Systems & Software, Inc., 3303 Harbor Blvd., Suite C-11, Costa Mesa, CA 92626; 714/241-8650
CIRCLE 336 ON READER SERVICE CARD

Version 4.0 of **MultiLink Advanced**, a multiuser, multitasking program from **The Software Link, Inc.** (TSL), is a shared processor that allocates RAM into foreground and background partitions to support multiple users at remote workstations. This version increases the maximum number of users (or tasks) supported by one PC/AT from 9 to 17, and with a memory-management board and sufficient memory, those users can be allocated partitions to run applications requiring as much as 600KB. The product supports color and graphics on terminals or terminal emulators that adhere to TSL's color/graphics protocol. Another enhancement is SuperCom, a programmer's tool for accessing serial communications ports. $595; update from 3.0 through 3.03 to 4.0, $100.
The Software Link, Inc., 8601 Dunwoody Place NE, Suite 632, Atlanta, GA 30338; 404/998-0700
CIRCLE 338 ON READER SERVICE CARD


COMPUTER INNOVATIONS
C86PLUS
C COMPILER
REFERENCE MANUAL
SUPREMACY.
C COMPILER



ANSYS screen, from Swanson Analysis System

Screen from Engineer Works by Cadetron

A memory-resident user-interface manager, **FLASH-UP WINDOWS**, has been introduced by **The Software Bottling Company of New York**. FLASH-UP WINDOWS is a full-screen window editor that creates windows sized from 4 lines by 4 columns to 24 lines by 80 columns. The user can change the position of the windows, send keyboard macros, or al low windows to control programs. $90.
The Software Bottling Company of New York, 6600 Long Island Expressway, Maspeth, NY 11378; credit card orders, 800/824-7888, ext. 268; in New York, 718/458-3700

CIRCLE 339 ON READER SERVICE CARD

Swanson Analysis Systems, Inc. reports that its finite analysis program, **ANSYS**, is available for the RT/PC. ANSYS is a general-purpose program for engineering analysis and design, and is used to determine displacements, forces, stresses, strains, temperatures, and magnetic fields. ANSYS-PC/LINEAR is a subset of ANSYS that offers linear static and model analysis on the PC/XT and PC/AT. Both programs integrate preprocessing, solution, post-processing, and graphics into one complete package. Monthly license on the RT/PC, $1,100.
Swanson Analysis Systems, Inc., Johnson Road, P.O. Box 65, Houston, PA 15342-0065; 412/746-3304

CIRCLE 343 ON READER SERVICE CARD

VenturCom, Inc. has introduced **VENIX E-NET 205**, a program that serves as the foundation for fully distributed application processing and communications in a multiple-vendor environment. Designed for system integrators, VENIX E-NET allows the PC/XT or PC/AT running VENIX System V to be linked to DEC VAX computers and other hardware connected via an EtherNet LAN using the TCP/IP protocol. VENIX E-NET uses the Excelan Inc. EXOS 205 Intelligent EtherNet Controller to provide TCP/IP protocol services to the host system. This combination increases networking throughput and application processing capabilities by downloading CPU-intensive, protocol processing functions to the EXOS controller, freeing the CPU for application processing. $595.
VenturCom, Inc., 215 First Street, Cambridge, MA 02142; 617/661-1230

CIRCLE 340 ON READER SERVICE CARD
Excelan Inc., 2148 Fortune Drive, San Jose, CA 95131; 408/434-2300

CIRCLE 341 ON READER SERVICE CARD

Burr-Brown Corporation announced a data acquisition software package for use with its PCI-20000 Data Acquisition System. Designated **PCI-0046S-5**, this package includes BASIC, C, Turbo Pascal, and ASYST language interfaces. The ASYST language interface, when used with the PCI-20000 System and ASYST modules 1 and 2 from Macmillan Software Company, allows direct data acquisition; easily reduces, manipulates, and analyzes acquired data; generates high-quality graphics; and integrates analysis functions, including Fourier analysis, with graphics. Each language interface package consists of a set of high-level calls to efficient assembly language subroutines. $450.
Burr-Brown Corporation, International Airport Industrial Park, P.O. Box 11400, Tucson, AZ 85734; 602/746-1111

CIRCLE 344 ON READER SERVICE CARD
Macmillan Software Company, 866 Third Avenue, New York, NY 10022; 212/972-3960

CIRCLE 345 ON READER SERVICE CARD

A three-dimensional solids modeling product, **The Engineer Works**, has been announced by **Cadetron, Inc.** Running on the PC/AT, this extended PADL2-based CAD software brings true solids modeling capabilities to the PC environment with features that include shading, mass properties, windowing, numerical control programming and verification, and finite element analysis meshing and post-processing. Data are transferable to numeric control (NC) machines and mainframe stress analysis packages. The system is written in C and runs under XENIX. Prices range from $3,000 to $15,000.
Cadetron, Inc., 1215 Hightower Trail, Suite B-100, Atlanta, GA 30338; 404/998-8095

CIRCLE 342 ON READER SERVICE CARD

Loopworks, a program for process monitoring and control from **Equinox Data Corporation**, offers realtime trend displays, sequence control, enhanced logic operations, configurable math capabilities, new signal processing features, PID (proportional integral derivative) and discrete control enhancements, and support for many I/O subsystems (such as data acquisition boards). It is available in three versions: Loopworks 100 is for applications in process monitoring, data logging, alarming, and discrete control; it provides 100 "records" that can be assigned to nearly any combination of digital or analog points. Loopworks 300 (300 records) is for multiloop PID applications, as well as large monitoring, discrete control, or supervisory systems. Loopworks 3000 (3,000 records) can configure very large or highly advanced applications process monitoring and control. Loopworks 100, $995; 300, $2,995; 3000, $4,995; evaluation version, $95; documentation, $75.
Equinox Data Corporation, 150 Nickerson Street, Suite 200, Seattle, WA 98109; 206/281-7327

CIRCLE 346 ON READER SERVICE CARD

Erratum: In the October 1986 Tech Releases, the top left photo on page 32 shows Microsoft's MACH 10 remote switch, not its InPort Mouse.

The material that appears in Tech Releases is based on vendor-supplied information. These products have not been reviewed by the PC Tech Journal *editorial staff.*

SUBSTANTIATED.

SUPREMACY

It's a bold claim. A claim we're prepared to stake our reputation on. And at Computer Innovations, we've always taken our reputation very seriously.

It's no industry secret that the competitive C Compilers are at the end of their optimization cycle — they're just about as good as they are going to get. C86PLUS begins where everybody else has left off. It's an entirely new technology based on artificial intelligence and advanced compiler design techniques. Designed with the serious programmer in mind, C86PLUS provides the ultimate development environment, matching unparalleled execution speed with a host of productivity features.

FAST EXECUTION

- 20% faster than Microsoft C, version 4.0
- 70% faster than existing C86, version 2.3
  (timings based on the classic sieve benchmark)

ANSI C COMPILER FEATURES

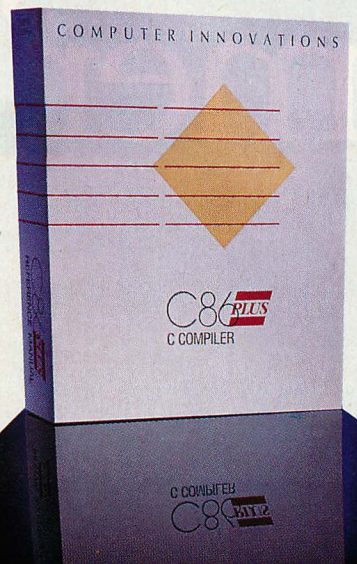
- Register variables
- Structure assignment
- Function prototypes
- New type modifiers
  - -near
  - -far
  - -signed
  - -const
  - -volatile
- Long double 80 bit floating-point
- Enumerator data types (enums)
- Extended preprocessor capabilities

FULL CONTROL OVER COMPILATION ENVIRONMENT

- Small, Medium, and Large memory models
- 8086/80186 and 80286 code generation options
- In-line 8087/80287 floating point
- 8087/80287 auto detect emulator
- Source level debugger support
- Wild-card compilation
- Make utility
- ROMable code
- Linkable with macro assembler output
- Intel-standard OMF object files
- Optional assembly language output
- Warning level control

EXTENSIVE FUNCTION LIBRARIES FOR INCREASED PRODUCTIVITY

- Over 250 library functions
- Full ANSI C library
- Functional equivalents to most UNIX System V libraries
- Shared file and network support
- Low-level machine access functions
- IBM ROM BIOS support routines
- Fully compiled small, medium and large model libraries
- C library source code
- Run-time start-up source code
- Source code librarian
- Object code librarian



MICROSOFT COMPATIBILITY

If you're a current Microsoft user, we invite you to consider this simple point. C86PLUS will recompile most applications developed using MS-C without changes to your source code. You'll find that your application runs much faster.

PROVEN EXPERIENCE

In 1981, Computer Innovations and its founder, George Eberhardt, revolutionized the DOS programming world with the introduction of the first C Compiler for the PC called C86. Today, C86 boasts a satisfied and loyal user base of over 20,000 programmers worldwide. C86PLUS represents an extension of this expertise and reputation. It's backed with more than a decade of intensive research and development.

PROVEN SUPPORT

Making the claim that C86PLUS is supreme is one thing, standing behind it is another. Computer Innovations has always offered timely and intelligent technical support, and this is an important customer service which we do not intend to change.

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The call is on us. For more information or to order call:

800-922-0169
or 201-542-5920 (in NJ)

C86PLUS™
COMPUTER INNOVATIONS

980 Shrewsbury Ave.
Tinton Falls, NJ 07724, USA
Telex: 705127 COMP INNOV UD

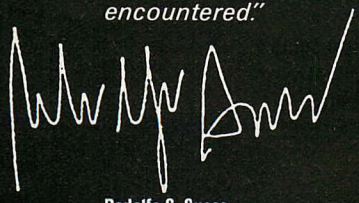
See us at COMDEX/Fall '86 Las Vegas Convention Center Booth 454

CIRCLE NO. 144 ON READER SERVICE CARD

"In the marketplace, the ultimate wisdom belongs to the customer."

(Bidwell's Law; *Good Reading*)

"I have been buying software from about six mail order houses in the U.S. and your response time has been the best that I have encountered."

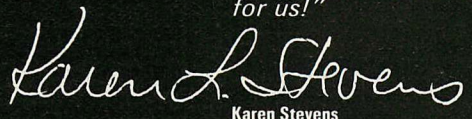


Rodolfo S. Suaco
Kowloon, Hong Kong

"In any company, it is a great rarity to find courteous and timely service, product knowledge objectively offered, more than reasonable prices, and a willingness to pursue the latest new market offerings. My experience strongly indicates Programmer's Connection considers this their minimum acceptable standard in meeting customer needs."

Craig Timko
Car Programs Management
Ford Motor Company

"I'm overwhelmed by how you bend over backwards to get things for us!"



Karen Stevens
Mindscape Software Inc.
San Jose, California

"I am delighted!...your service is excellent. This is my first dealing with Programmer's Connection, but not the last, I am sure."

Ken Travers
KenT Computer Services
Hornsby Heights, Australia

"Excellent service, excellent selection."

Reported by **Mark Ackerman**
For the Boston Computer Society *PC Report.*

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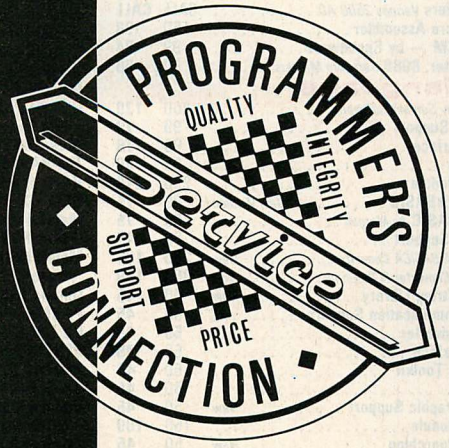
When we started Programmer's Connection in 1984, we dedicated ourselves to providing high quality personal service to every customer. Since then, we've quickly grown to be the leading independent dealer in this industry.

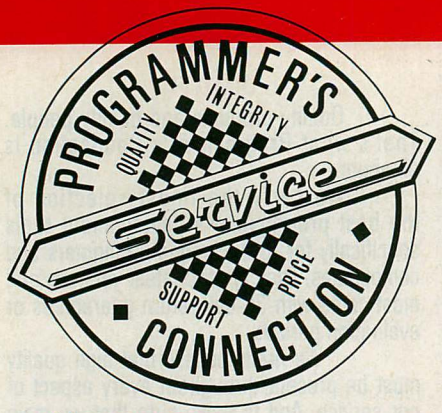
We're very proud of the trust we've earned from our customers and we pledge always to be worthy of it.

◆◆◆

It's our commitment to quality, support, low prices and integrity that sets us apart. So make the connection today and find out for yourself what our customers are talking about.



Turn the page for our product listing and ordering information.



apl language

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arity products

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artificial intelligence

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ExpertEDGE Professional *by Human Edge* .. *New*	5000	CALL
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Logic-Line Series 2 *by Thunderstone*	125	115
Logic-Line Series 3 *by Thunderstone*	150	139
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with **APES**	450	399
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assembly language

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basic language

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REFLEX Workshop	70	55
REFLEX & REFLEX Workshop	200	149
Turbo DATABASE TOOLBOX	70	50
Turbo EDITOR TOOLBOX	70	50
Turbo GAMEWORKS TOOLBOX	70	50
Turbo GRAPHIX TOOLBOX	70	50
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Turbo PASCAL *with 8087 and BCD*	100	69
Turbo Prolog Compiler	100	75
Turbo TUTOR *for Turbo PASCAL*	40	28
Word Wizard	70	50
Word Wizard and Turbo Lightning	150	119

c++

C++ *from Guidelines* ..... *New*	195	179

c compilers

C-86 *by Computer Innovations*	395	279
Datalight C Compiler *Small Model*	60	49
Datalight Developer Kit *w/Large Model*	99	79
DeSmet C *w/Debugger*	159	145
DeSmet C *w/Debugger & Large Case*	209	193
Eco-C *Development System by Ecosoft*	125	89
Lattice C Compiler *from Lattice*	500	294
Mark Williams Let's C	75	58
with **csd** *Source Debugger*	150	109
Mark Williams MWC-86	495	289
Microsoft C *with CodeView*	450	288
Wizard C Combo *by Wizard Systems* ..... *New*	750	599
Wizard C Compiler	450	359
ROM Development Pkg ..... *New*	350	299

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C Trainer *by Catalytix* ..... *New*	99	CALL
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Introducing C *by Computer Innovations*	125	104
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Basic C Library *by C Source*	175	129
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C-ISAM *by Relational Database Sys* ..... *New*	225	195
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c-tree *ISAM File Manager by FairCom*	395	329
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dbVISTA *Single-User DBMS by Raima*	195	155
with Source Code	495	425
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dBx *dBase/C Translator by Desktop AI*	350	325
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Essential Graphics *by Essential Software*	250	205
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GraphiC *Mono v2.2 by Sci Endeavors*	280	209
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GRAFLIB *by The Librarian* ..... *New*	175	CALL
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cobol language

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Micro Focus Professional COBOL	3000	2295
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forth language

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fortran language

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GRAFLIB *by The Librarian* ..... *New*	175	CALL
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PLOTHP *by The Librarian* ..... *New*	175	CALL
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with Library Source Code	900	545
C Cross Reference Generator	50	39
with Source Code	200	149
C-Food Smorgasbord *Function Library*	150	98
with Source Code	300	188
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Curses *Screen Manager*	125	94
with Source Code	250	184
dBC *dBase File Manager for C*	250	189
with Source Code	500	378
LMK *Make Facility*	195	145
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SideTalk *Resident Communications*	120	94
Text Management Utilities	120	94
TopView Toolbasket *Function Library*	250	189
with Source Code	500	378
Z-80 C Cross Compiler	500	378
with Library Source Code	1000	749

logitech products

LOGIMOUSE C7 *Mouse Hardware*	99	85
with PLUS Pkg	119	99
with PLUS Pkg & PC Paintbrush	169	145
with PLUS Pkg & CAD Software New	189	159
with PLUS Pkg & CAD & Paint New	219	189
MODULA-2/86 Compiler	89	63
MODULA-2/86 with 8087 Support	129	103
MODULA-2/86 PLUS	189	147
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Make Utility New	29	27
ROM Package New	199	179
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for XENIX	995	639
Microsoft COBOL Tools *with Debugger*	350	208
for XENIX	450	319
Microsoft FORTRAN Compiler	350	208
for XENIX	695	445
Microsoft Learning DOS New	50	CALL
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Microsoft MACH 10 *Board* New	399	CALL
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Microsoft Mouse *Bus Version* New Version	175	139
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Microsoft muMath *Includes muSIMP*	300	189
Microsoft Pascal Compiler	300	189
for XENIX	695	445
Microsoft QuickBASIC	99	75
Microsoft Sort	195	139
Microsoft Windows	99	68
Microsoft Windows Development Kit	500	329

other languages

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Janus/ADA C Pack *by R&R Software*	95	89
Janus/ADA D Pack *by R&R Software*	900	795
Methods *Smalltalk by Digitalk*	79	68
Personal REXX *by Mansfield Software*	125	109
Smalltalk/V *by Digitalk*	99	88
Smalltalk/Comm New	49	45
SNOBOL4+ *by Catspaw*	95	84

other products

Dan Bricklin's Demo Pgm *Software Garden*	75	59
FASTBACK *by 5th Generation Systems*	179	149
Informix *for DOS by RDS* New	795	639
Informix4GL *for DOS by RDS* New	995	799
InformixSQL *for DOS by RDS* New	795	639
Inside Track *from Micro Help* New	65	55
Instant Replay *by Nostradamus* New	90	79
Interactive EASYFLOW *by Haventree*	150	129
MACH 2 *by Micro Help* New	75	65
MKS Toolkit *with vi by MKS* New	139	119
OPT-Tech Sort *by Opt-Tech Data Proc*	149	115
Peeks 'n Pokes *from Micro Help* New	45	39
PrintQ *by Software Directions* New	89	84
Quilt Computing Combo Package	199	169
QMake *Program Rebuild Utility*	99	84
SRMS *Software Revision Mgmt Sys*	125	109
screenplay *all varieties by Flexus* New	CALL	CALL
Source Print *by Aldebaran Labs*	139	115
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VTEK, Term Emulator by Sci Endeavors New	150	129

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Pdisk *Hard Disk Utility* New	195	129
Pfantasy Pac	1295	879
Pfinish *Performance Analyzer*	395	239
Pfix-86 *Program Debugger*	195	135
Pfix-86 Plus *Symbolic Debugger*	395	239
PforCe *Comprehensive C Library*	395	239
Plink-86 Plus *Overlay Linker*	495	329
Pmaker *Make Utility* New Version	125	89
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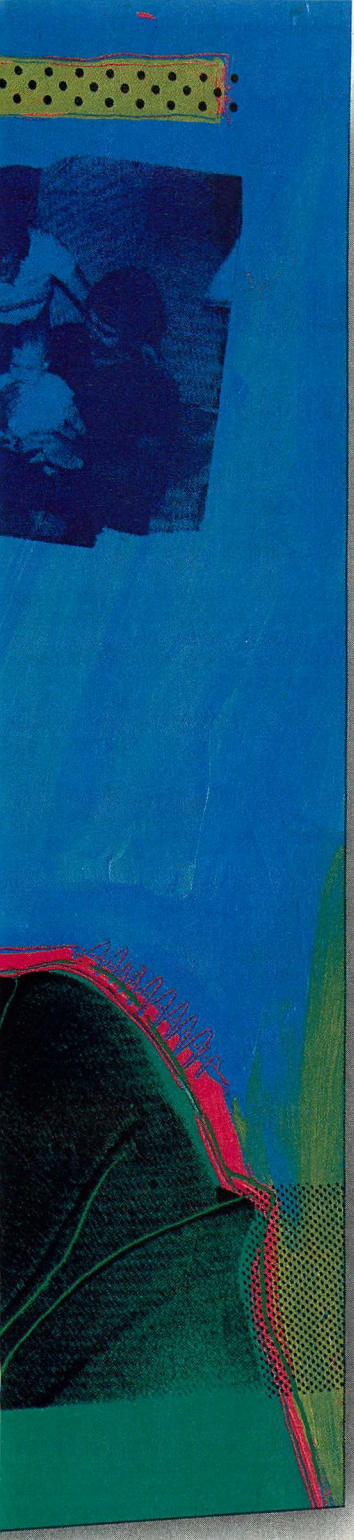

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TECH NOTEBOOK 69

JIM VALLINO

Environment Expansion

A patch to the COMMAND.COM file increases the size of the DOS environment to hold additional variables and strings.

Version 2.0 of MS-DOS marked the first appearance of the environment feature—a block of memory reserved by the operating system to hold several system environment variables and equated ASCII strings. Whenever a program is run, the operating system makes a copy of the environment and then passes to the program the segment address of this copy at offset 2CH in the program segment prefix (PSP). Many applications search this environment for variables that specify user preferences for information such as the directories in which auxiliary files are placed.

The user manages the environment variables using the SET command. Variables may be added, deleted, changed, or displayed with this command. Memory space for the environment is allocated during the booting of COMMAND.COM using the Allocate Memory (48H) function of DOS. This block of memory is placed just above the resident portion of the operating system with a default initial size of 10 paragraphs (160 bytes). As variables are added, the environment is increased up to a maximum of 32KB provided that contiguous memory space is available for the increase in size.

Unfortunately, expansion of the environment is often prevented. Just beyond DOS's environment memory block is the free memory used for loading application programs. When a program is loaded into this area it limits the size of the environment to its current memory allocation. If this program is one of the many utilities that remains resident, then the size limitation is permanent. Even if no terminate-and-stay-resident programs are run, defining many environment strings from the command line can be tedious.

What most users would like to do is place all of the SET commands into a batch file such as AUTOEXEC.BAT. However, the operating system will load information for the running of this batch file just above the environment, effectively freezing its current size. The solution is to increase the number of paragraphs requested for the default environment memory block. This is done in DOS 2.x and 3.0 by patching COMMAND.COM, whereas in versions 3.1 and 3.2 a feature of the SHELL command makes a patch unnecessary.

Whenever attempting to patch the operating system the user should perform the work on a backup copy of the DOS diskette in case something goes wrong. The new copy should be placed in drive A: and DEBUG A:COMMAND.COM run. The relevant assembly code is:

ASSEMBLY CODE	MACHINE CODE	
MOV BX,0A	BB 0A 00	;Load BX with number of paragraphs
MOV AH,48	B4 48	;Specify Allocate Memory function
INT 21	CD 21	;Execute DOS function

Use the DEBUG command S 100 L 4500 BB 0A 00 B4 48 CD 21 to find the location of this piece of code. Unassembling the program at this location should display the first three instructions shown above. If the instructions do not correspond, the operation steps should be checked again. (This code does not appear in DOS 3.1 and 3.2; if these versions are being used, see the section below for the correct procedure to follow.) At the address displayed, assemble a new instruction, which loads the BX register with the size desired. Remember that the number loaded into BX is understood as a hexadecimal value specifying the number of paragraphs (times 16 for bytes) in the default environment. Check the modification by then unassembling again.

Once the change is satisfactory, write it back to the diskette and exit DEBUG. Then reboot from this diskette and perform a simple operation (such as DIR) to see if the operating system still functions. If it still functions correctly, copy the patched COMMAND.COM to the root directory of the disk from which the computer is normally booted. Be sure that a backup of the patched version of the operating system is made to be restored to the boot disk if ever needed.

To verify that the environment is enlarged, create a batch file with several SET commands, which define strings with a total of more than 160 bytes but less than the new size of the environment. Typing SET without any parameters lists the entire contents of the modified environment.

Beginning with DOS 3.1, a feature of COMMAND.COM and the SHELL statement used in CONFIG.SYS allows a user to specify the size of the default environment. This feature was not documented in the IBM literature until DOS 3.2, although it is available in a slightly different form in DOS 3.1. The IBM DOS 3.1 documentation does not mention that the SHELL command includes an option that defines the size of the default environment.

Put a SHELL statement in the CONFIG.SYS file using the following command format:

SHELL<command-file> /P /E:xx

where **<command-file>** is the full path name for COMMAND.COM, and **xx** is the size of the default environment. This size is given as a decimal value representing in version 3.1 the number of paragraphs in the environment and in version 3.2 the number of bytes. The **P** option instructs COMMAND COM to execute the AUTOEXEC.BAT file, or date and time if no AUTOEXEC.BAT is present when the command processor is loaded.

Jim Vallino is a PC programmer with more than a decade of experience in microcoding, high-level applications, and assembly language. He also teaches a college-level course in C programming.

Sometimes a combination of ideas ends up defying conventional thinking. However, their relationship seems natural after the fact. It's the kind of association that leads to maximum performance from minimum means. Ideas like the combined technology of multiple 32-bit microprocessors with mainframe architecture, concurrent on-demand operating systems and high-end file server/networking capability.

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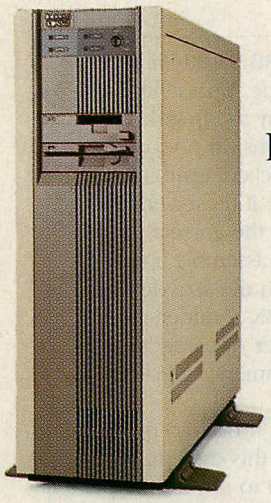

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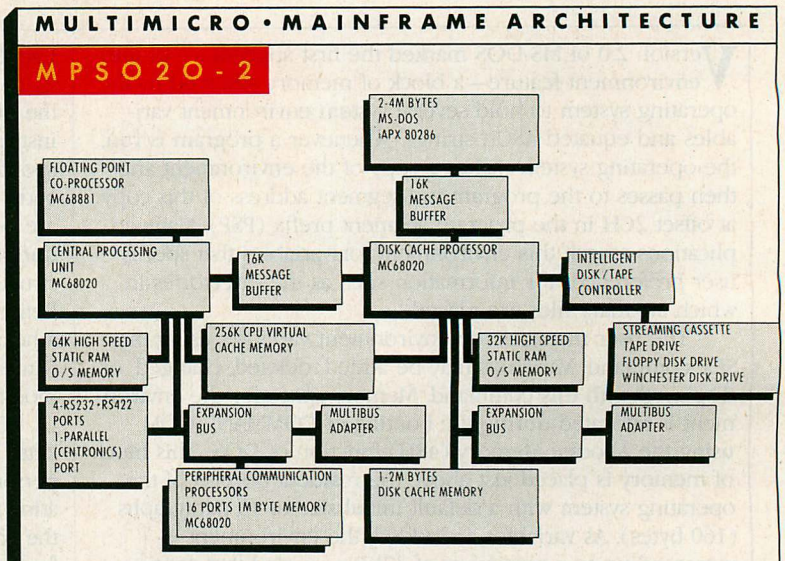

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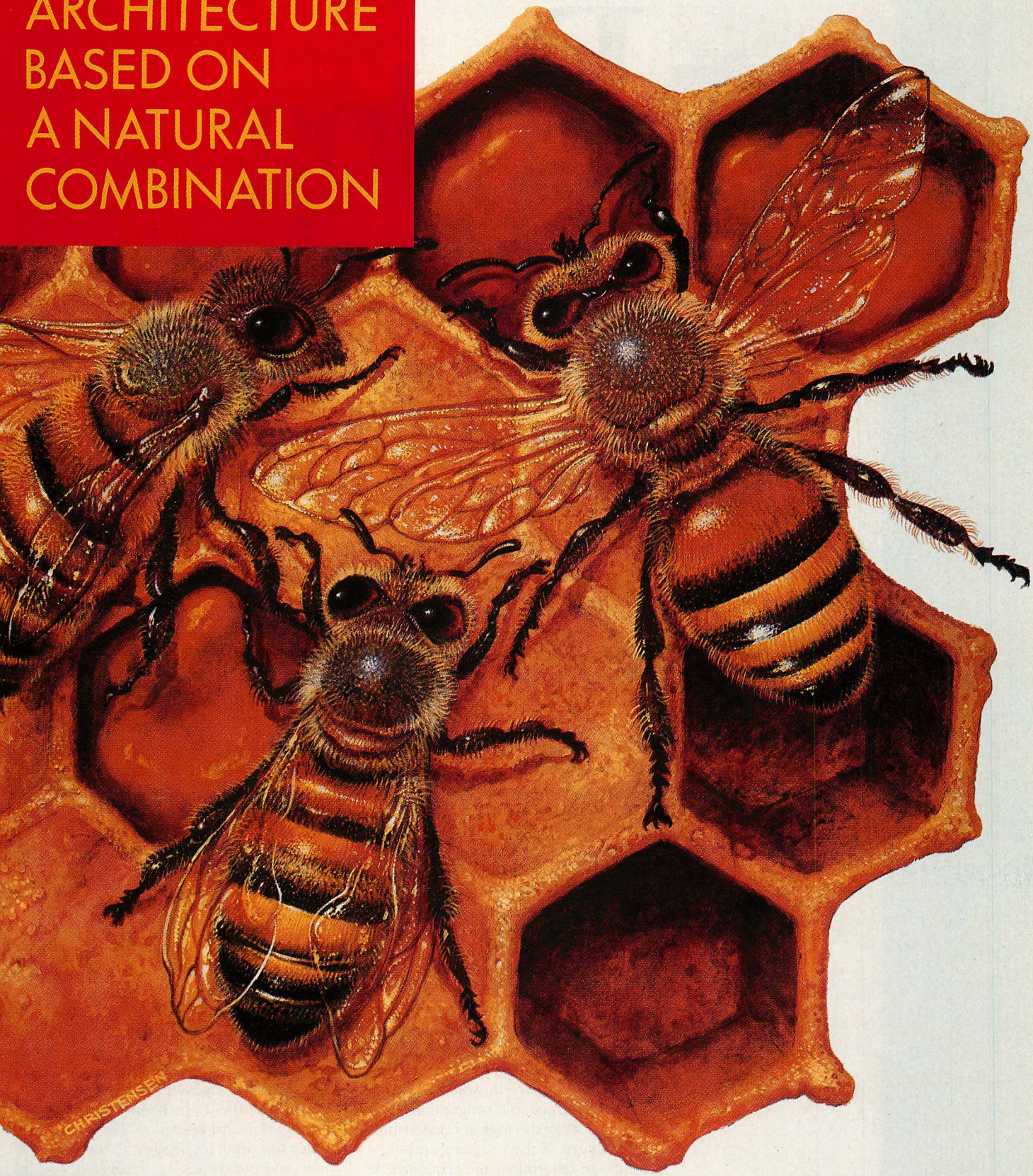

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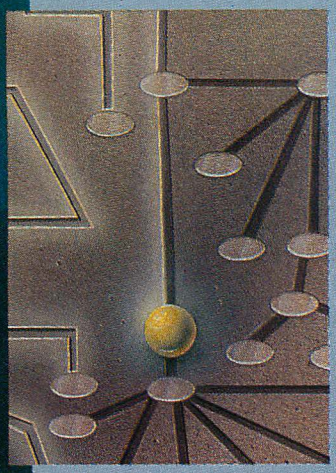

Prolog Arrives

The better Prolog compilers now appearing are powerful and faster than Prolog interpreters; they also bring the language closer to a recognized standard and more widespread use.

MICHAEL COVINGTON and ANDRE VELLINO

In the history of artificial intelligence (AI), 1986 will be remembered as the year Prolog moved out of the laboratory and onto the PC. This new programming language is quickly displacing LISP in a wide range of applications, especially automated reasoning and natural language understanding. The fact that good implementations of Prolog are showing up on IBM PCs—rather than just high-priced AI workstations—means that the power of artificial intelligence technology soon will be in the hands of PC users.

Prolog is the first major nonprocedural programming language. Instead of breaking a program into steps and specifying the sequence in which actions are to be performed, the programmer is able to specify the logical relationship among parts of the program, and the computer determines the sequence. At least, that is the ideal. In practice, however, most Prolog programs contain some conventional procedural code; even then, the program benefits from the logical elegance of the language and the availability of features such as recursion and list processing.

Nine Prolog interpreters and one somewhat flawed compiler were reviewed in "Programming in Logic" (Michael Covington, December 1985, p. 82 and January 1986, p. 145). Since then, three reasonably good compilers have appeared on the market—Arity Prolog (Arity Corporation), Prolog-2 (Expert Systems International), and Turbo Prolog (Borland International)—and their power rivals the best Prologs available for larger machines.

In a sense, a Prolog compiler is a contradiction in terms. The action of a compiler is to translate programs from high-level languages into machine code. With Pascal, BASIC, or FORTRAN, this is a straightforward operation. The user writes the program, feeds it to the compiler, and out comes the translation, usually in a .EXE file. Prolog programs, on the other hand, can modify themselves as they run; because the compiler cannot tell what additional instructions the program is going to insert into

ILLUSTRATION • ANDY LEVINE

itself, it has no way of knowing what translation to produce.

One route out of this dilemma is to use an interpreter instead of a compiler. The interpreter executes statements one by one without producing a machine code translation. If the program modifies itself, the interpreter processes the modifications as if they had been present all along. The only down side is that interpreted programs are much slower than compiled ones.

The compilers reviewed here offer various solutions. Prolog-2 runs programs under an interpreter even if they have been compiled. Thus the interpreter can process instructions that are changed during execution. Turbo Prolog produces stand-alone .EXE files, but it implements only a subset of Prolog that greatly restricts the ability of programs to modify themselves. Arity Prolog takes what may be the best approach: it produces .EXE files that contain not only the user's compiled program, but also the core of a Prolog interpreter for handling instructions changed at runtime. The compilers' features are compared in table 1.

POWER FOR AI

Prolog's backward-chaining process makes it ideal for writing programs that involve trying different possibilities. In *backward chaining*, the computation begins with a possible conclusion, or *goal*, and works backward to discover whether the conclusion can be deduced from the data. Examples range from choosing moves in games to designing electronic circuitry from available parts. Backward chaining is also a vital part of natural language understanding routines, such as recursive descent parsers (see PARSER.PRO, listed with the December article on page 95).

Moreover, Prolog can automatically organize parts of a program into a coherent whole. This ability is crucial for building *expert systems*—programs that give advice to humans. Consider a program to diagnose faults in machines. In order to write such a program in a conventional language, the programmer probably would have to start with a flow chart or a logic tree for all possible diagnoses. In Prolog the diagnostic data can be entered piecemeal: if the correct conditions are attached to each piece, Prolog automatically imposes the correct structure on the overall program. (See EXPERT.PRO, also listed with the December article on page 95.)

Top-down programming is also very natural in Prolog; its procedure-calling style encourages modular

TABLE 1: *Features Comparison*

	ARITY	EXPERT SYSTEMS	BORLAND
BASIC FACILITIES			
Product	Arity Prolog	Prolog-2	Turbo Prolog
Version	4.0	1.21	1.1
Available for other systems	○	○[a]	○
Copy protected	○	●[b]	○
Memory required (KB)	512	384[c]	384
Hard disk recommended	●	●	○
Produces .EXE files	●	○	●
Self-modifying programs	●	●[d]	○[e]
Modular programs	●	●	●
Programs larger than RAM	●	●	●[f]
DEVELOPMENT ENVIRONMENT			
Edinburgh-style interface	●	●	○
Windows	○	●	●
Editor provided	○[g]	●	●
Tracing	●	●	●
Interactive debugging	●	●	○
Lint syntax checking	●	●	○
On-screen help	○	●	●[h]
DATA STRUCTURES			
Type declarations required	○	○	●
Untyped lists	●	●	○
Strings (distinct from lists)	●	●	●
ARITHMETIC FUNCTIONS			
Maximum integer	32,767[i]	8,388,607	32,767
Maximum floating-point number	1.0E+99	1.0E+308	1.0E+308
8087 support	●	●	○
Trigonometric functions	●	●[j]	●
FILE SYSTEM			
Multiple files open at once	●	●	●
Random access I/O	●	●	●
SCREEN I/O			
Screen and cursor control	●	●	●
Removable windows	○	●	●
Full-screen editing when typing in a window	○	●	●
Graphics	○	○	●
INTERFACING			
DOS shell tasks	●	●	●
Perform any interrupt	○	○	●
Peek and poke	○	○	●
Call other languages	●	●	●
Use LINK with .OBJ files	●	○	●

● = *Yes* ○ = *No*

[a] *Plans for VAX/VMS, UNIX.*
[b] *Copy protection will be removed in version 1.24.*
[c] *512KB recommended.*
[d] *A single program can include both interpreted and compiled code, but only the interpreted part can be modified during execution.*
[e] *Facts can be modified under some conditions, rules cannot.*
[f] *Facts can be stored on disk, rules cannot.*
[g] *Can be configured to use any editor provided by the user.*
[h] *For editor only.*
[i] *Automatically switches from integers to floating-point upon overflow.*
[j] *Only with 8087.*

These three Prolog compilers present the buyer with clear alternatives. Arity Prolog offers a completely efficient and faithful implementation of a superset of Edinburgh Prolog; spartan but powerful, it is intended for serious application development. Prolog-2, written in Prolog, is flexible but extremely slow. Turbo Prolog has an excellent user interface but runs an incomplete version of the language.

THE PROLOG STANDARD: UNOFFICIAL, BUT HIGHLY RESPECTED

Currently, no official standard exists for Prolog. However, the groundwork for establishing a standard was laid by the first efficient Prolog compiler. Written by David Warren at the University of Edinburgh in 1977, the DEC-10 Prolog compiler established a syntax for the language that is now referred to as Edinburgh Prolog. The design decisions made for that implementation have been crucial to the development of a Prolog standard.

The popularity of Edinburgh Prolog is due partly to its adherence to the widely accepted Clocksin and Mellish standard text and partly to the syntactic power of the language itself, which includes the ability to create additional operators and to specify their precedence in a program.

Virtually all implementations of Prolog for the PC claim to use Edinburgh syntax, although almost all of them deviate from it, if only slightly. Edinburgh syntax is also the basis of Quintus Prolog, the most popular implementation for minicomputers and engineering workstations.

Even with the recognition being given Edinburgh Prolog, the process of formally standardizing Prolog has barely begun. Because the language originated in France (Marseilles) and Great Britain (Edinburgh), it is not surprising that the first and only standards organizations to have broached the issue of standardization are the British Standards Institute (BSI) and the Association Francaise de Normalization (AFNOR). Neither ANSI nor ISO has established a standards committee for Prolog in the United States.

Prolog implementations differ in syntax, as discussed in the sidebar "Two Syntaxes for Prolog" (with the December 1985 article on page 91). If the issue of standardization were limited to syntactic considerations, such as whether to designate conjunction with , or & , or what to name predicates that perform a standard function, it would be a relatively simple matter to write translation programs that convert from one syntax to another. But implementations of Prolog also differ in their built-in predicates, particularly those that perform actions such as I/O. The core DEC-10 predicates for I/O (**seeing, see, seen, telling, tell, told, get0, read, write, put,** and **display**) are implemented in most Edinburgh-style Prologs, but many of those extend the core language by implementing additional I/O predicates and other data types, such as character strings.

In addition, the behavior of some built-in predicates can vary significantly. A recent study by Chris Moss (Imperial College, London) shows that ! (cut), the control predicate that prevents backtracking, behaves quite differently in several major implementations of Edinburgh Prolog. One of these tests, **test0** in CUTTEST.PRO (listing 8), prints "cut in not does not act" in Prolog-2, but prints nothing in Arity or Turbo Prolog.

Semantic differences among Prologs therefore pose a serious threat to the portability of the language's code: a standard that specifies the behavior of essential built-in predicates is much to be desired. On the other hand, Prolog is being extended and refined as research into logic programming advances and there is something to be said for letting programmers experiment with the language.

Recent developments include an Australian implementation of Prolog (Mu-Prolog) that makes the declarative reading of programs much clearer by including the quantifiers **some** and **all** in the syntax. Prolog II, developed by Alain Colmerauer's group, includes a **freeze** predicate that suspends the execution of a predicate until its variables are bound. Also a "soft cut" operator with limited scope (called *snips* in Arity Prolog) is appearing in many implementations and offers more flexibility than regular cut.

These and other enhancements probably should be explored further before definitive standards are set.

All of these considerations mean that some deviation from Clocksin and Mellish is acceptable (although Turbo Prolog has taken it too far). If the Clocksin and Mellish subset of DEC-10 Prolog is adopted as the official standard, even only in part, it is fairly safe to assume that the following basic built-in predicates will be included. At present, they are included in both Arity Prolog and Prolog-2, but not in Turbo Prolog:

call(Goal)	inserts the value of **Goal** into the program and executes it, making it possible to execute a goal created by computation
Struct .. Lst	converts a list to a structure or visa versa
functor(S,N,A)	gives the name and arity of a structure
arg(N,T,X)	**X** is the *n*th argument of the term **T**
clause(H,B)	matches **B** with the body of a clause that has the head **H**
assert(C)	adds clause **C** to the program (in Turbo Prolog, it can add facts, but not rules)
retract(C)	deletes clause **C** from the program (present in Turbo Prolog, but can only delete facts)
P ; Q	succeeds if **P** or **Q** succeeds

Part of the problem is that the name Prolog has been applied to nearly every backward-chaining logic programming language ever implemented. The name should be applied only to the language described by Clocksin and Mellish. After all, not every procedural language ever created has been called FORTRAN.

—Michael Covington and Andre Vellino

design. For example, consider a program that takes one stream of characters and returns another:

```
main : –
        read_input (stream 1),
        process (stream 1, stream 2),
        write_output (stream 2).
```

The predicates of the main clause communicate only through **stream 1** and **stream 2**. Prolog has no global variables and no assignment statements to change a variable's name.

Prolog can express algorithms that do not involve backward chaining. A special operator called *cut* (and written !) prevents backtracking where it is not wanted. Looping is expressed through recursion, and alternative clauses in predicates do the work of IF...THEN and CASE statements. (For a detailed discussion of the history and development of an acceptable Prolog language standard, see the accompanying sidebar on this page "The Prolog Standard: Unofficial, but Highly Respected.")

In formal logic, the order in which clauses are written is insignificant—all orderings are equivalent. But in Prolog, the ordering of clauses is critical to

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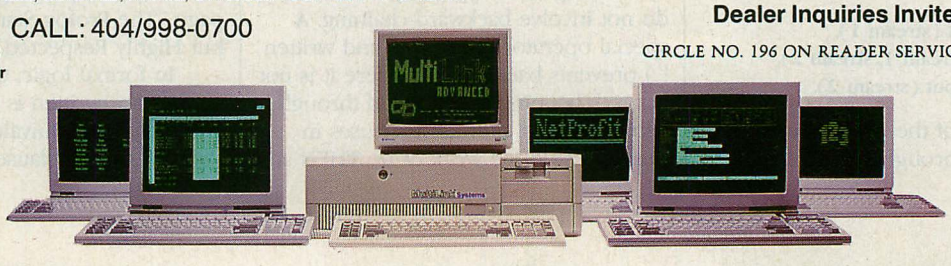

execution. For example, a recursive predicate that counts the number of elements in a list is

```
length([],0).
length([H|T],N) :-
    length(T,M),
    N is M + 1.
```

The first clause provides the terminating condition: the empty list has length 0. The second clause says that a list with a first element of H and a remainder of T has a length that is equal to 1 plus the length of T.

Note first that the terminating condition *must* precede the recursive definition. In attempting to solve **length(T,M)** Prolog attempts to match it with **length([],0)**, and failing that moves to the next clause. However, if the terminating condition were written *after* the recursive part, the program would never terminate. Other seemingly harmless rearrangements also fail. For reasons of efficiency, it is better to place the recursive call last, a formulation called *tail recursion*:

```
length([H|T],N) :-
    N is M + 1,
    length(T,M).
```

This clause expresses the same declarative content as the prior clause, but it cannot execute the arithmetic statement **N is M + 1** until **M** is bound to a value—that is, until it reaches **length(T,M)**. Therefore **length(T,M)** must precede the arithmetic statement.

Prolog shares with LISP two features that are nearly indispensable to AI. First, both languages use dynamic data structures: a program can create lists and add information to them without having to state first the amount of memory needed, or even what form each element in a list will take. (In contrast, Pascal arrays and records always must be declared in advance.) This dynamic structure of lists within lists permits the representation of the complex arrangements of knowledge necessary to expert systems.

Second, Prolog and LISP programs can examine and modify themselves using built-in predicates. An expert system written in Prolog can gather new information as it interacts with a user, then add the data to itself for future use. The predicates **asserta** and **assertz** add new rules at the beginning and end of the program respectively; **retract** removes rules from the program. The predicate **clause** retrieves all rules that match a given query.

Perhaps more importantly, a program can create a query by performing some computation, then insert the query into itself and execute it as if it had been present all along. This is necessary whenever a program accepts queries in some format other than Prolog syntax—natural langauge input or menu selections, for example. Such a program typically contains a routine that accepts input in the foreign format, translates it into Prolog, then executes it. The Prolog code might be

```
?- read(S),
    translate(S,Q),
    call(Q).
```

Here **call(Q)** means "execute the query that is stored in the variable Q." In many implementations, just Q can be used instead of **call(Q)**. Whatever syntax is used, the effect is exactly as if the following were possible in BASIC (although it is not):

```
10 A$="PRINT B+C"
20 B=2
30 C=35
40 A$
```

Writing a Prolog interpreter in Prolog involves writing a program that reads queries from the keyboard, inserts them into itself, then executes them.

THREE APPROACHES

The compilers were reviewed based on the assumption that they would be used to write application programs, not just to experiment with the language. In addition, they were judged on ease of use and the ability to produce an end product—a .EXE or similar file—that can be delivered conveniently to an end user. In addition, each compiler comes with a program development environment for editing and debugging, and debugging facilities were evaluated.

Prolog shares with LISP two features that are nearly indispensible to AI: dynamic data structures and program self-modification.

The benchmark programs listed here are based on those used in the Prolog interpreters review. The programs had to be expanded because the new compilers execute the original benchmarks too quickly to measure accurately. The 101-rule database search program has been replaced with a more comprehensive search-and-backtrack benchmark. All benchmarks were run on a PC/XT with 640KB of RAM, a 10MB IBM hard disk, and DOS 2.1. Programs were timed with a stopwatch.

The benchmarks also were run on an 8-MHz, 80286-based Tandy 3000 HD with 640KB of RAM, a 20MB hard disk, and DOS 3.1. These timings should be virtually the same as results that would be produced using an 8-MHz AT. In all cases, the tests used whatever memory allocation the compiler provided by default. (All three permit the user to change the amount of memory allocated to various uses.) The benchmark times are summarized in table 2.

The results of the speed tests are given in seconds and in LIPS (logical inferences per second)—one logical inference is the successful matching of a query with the left side of a rule. Although considered a standard unit, LIPS is an inadequate measure of Prolog speed because the actual LIPS rate depends not only on the compiler, but also on the program being executed—it does not account for the number of unsuccessful matches that are tried before a successful match is found. A program with only one rule can run up a very high LIPS rate simply because no searching is necessary.

The listings are presented in Edinburgh Prolog (see the sidebar on the Prolog standard for a discussion of Edinburgh Prolog). Each compiler requires additional declarations to indicate where execution is to begin. Aside from that, Arity Prolog and Prolog-2 are completely compatible with Edinburgh. Turbo Prolog, on the other hand, requires extensive type declarations and alterations of syntax.

ONERULE.PRO (listing 1) is a one-rule speed test from the original interpreter benchmarks. It generally produces the highest possible LIPS rate, but is otherwise uninformative. TAIL.PRO (listing 2) and CENTER.PRO (listing 3) measure the amount of memory available for recursion by counting the number of times a procedure can call itself. In TAIL.PRO, the procedure calls itself as the very last step (tail recursion); in CENTER.PRO, it calls itself with some steps remaining to be executed. CENTERT.PRO (listing 4) is the Turbo Prolog adaptation of CENTER.PRO; all other benchmarks had to be adapted for Turbo in analogous ways.

A limit is always imposed on the depth of center recursion because a record of the steps remaining to be executed—the procedure's *continuation*—has to be saved on a push-down

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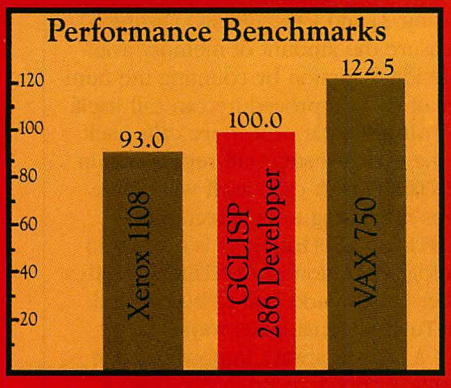

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*The results are found by taking the mean of the benchmark results from the performance and evaluation of LISP Systems by Richard P. Gabriel, normalized by the times of the GCLISP 286 Developer running on a COMPAQ Portable 286.

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TABLE 2: *Performance Benchmark Results*

	ARITY	EXPERT SYSTEMS	BORLAND
Product	Arity Prolog (compiled)	Prolog-2 (compiled)	Turbo Prolog
Tail recursion depth limit	No limit	No limit[a]	No limit
Center recursion depth limit	2,714	1,182	936[b]
Files needed to run compiled program (bytes)	SRCHBACK.EXE (65,520) SRCHBACK.IDB (4,598) SRCHBACK.P00 (22,534)	SRCHBACK.PRM (5,760) Requires interpreter to run	SRCHBACK.EXE (41,887)
IBM PC/XT			
One-rule speed test	0:20.4 (1,500 LIPS)	0:02.3[c] (1,300 LIPS)	0:00.8 (37,500 LIPS)[d]
List reversal	0:33.5 (1,000 LIPS)	0:00.6 (2,000 LIPS)[e]	0:07.85 (4,200 LIPS)
Search-and-backtrack	0:05.2 (6,700 LIPS)	0:08.1 (4,000 LIPS)	0:03.3 (10,000 LIPS)
Quick list reversal[f]	0:11	0:09.6	0:04
Compile and link SRCHBACK.PRO	1:20	8:14[g]	0:19
TANDY 3000 HD			
One-rule speed test	0:05.5 (5,500 LIPS)	0:00.6[c] (5,000 LIPS)	0:00.4 (225,000 LIPS)[d]
List reversal	0:09.6 (3,500 LIPS)	0:00.6 (N/A)	0:02.2 (15,000 LIPS)
Search-and-backtrack	0:05.2 (18,200 LIPS)	0:02.3 (14,200 LIPS)	0:09 (36,400 LIPS)
Compile and link SRCHBACK.PRO	0:32	2:40[c]	0:10

[a] The user must specify state (qc, stacks).
[b] This was not affected by the stack size option.
[c] Time shown for 1,000 iterations rather than 10,000. Prolog-2 ran out of stack space when attempting 10,000 iterations.
[d] Time for 30,000 iterations rather than 10,000. With 10,000, execution was too fast to measure accurately.
[e] Reversing a 50-element list; Prolog-2 could not allocate enough memory to reverse the 256-element list used to test the other compilers. See text.
[f] Took 14 seconds (0:14) in Turbo Pascal.
[g] Time to compile only.

All times are in minutes:seconds.
LIPS = logical inferences per second.
Results were rounded to 2 significant digits.
The benchmarks were run on a PC/XT with 640KB RAM, an IBM 10MB hard disk, and running DOS 2.1, and on a Tandy 3000 HD 80286-based system running at 8 MHz.

Turbo Prolog achieves impressive execution speeds, especially in the shorter benchmarks, but programs written to the Edinburgh standard had to be modified extensively to run under this compiler, which implements only a subset of the language.

stack. The compilers have relatively high limits, whereas some of the interpreters tested had limits below 200.

The Prolog compilers place no limit on tail recursion because they recognize that it can be performed without using up memory. If a procedure calls itself as its very last step, nothing need be saved on the stack because nothing will be done after return. With all three compilers, TAIL.PRO went through more than 10,000 iterations before it was interrupted manually. Arity Prolog and Turbo Prolog offer unlimited tail recursion as the default; Prolog-2 allows unlimited tail recursion only when the program contains the directive **? state(gc,_,stacks)**. to initiate reclamation of any unused memory.

REVERSE.PRO (listing 5) uses a classic but inefficient recursive algorithm to reverse the elements of a list—a standard benchmark for Prolog and LISP systems. Arity and Turbo Prolog were tested on reversing a 256-element list (33,153 logical inferences). This test could not be run on Prolog-2 because adequate memory could not be made available: although it can be changed by the user, the Prolog-2 stack space can never exceed 48KB. It also was impossible to run a tail-recursive program to reverse a 30-element list 100 times. Instead, the result for Prolog-2 is a rough timing for a program that reverses a 50-element list once. (This result may not be comparable to those for programs that processed larger lists.)

SRCHBACK.PRO (listing 6), the backward chaining benchmark, is a new test. It measures the speed with which a program can search through a large number of rules without doing arithmetic or other computation.

Other points of comparison in the review include usefulness of documentation, presence of copy protection, and portability versus speed.

ARITY PROLOG

The Arity Prolog Interpreter and Compiler (from Arity Corporation) offers a completely efficient, faithful implementation of a superset of Edinburgh Prolog. Version 4.0 is a major revision with new documentation. The price has been lowered (from $1,950 to $795) and copy protection has been dropped. The software comes on three 360KB floppy disks and requires 512KB of RAM. A hard disk is recommended.

Compilation and execution are quite fast with this compiler. It produces stand-alone .EXE files without compromising the power of the language, and no royalties are imposed on generated code provided the end product is not a Prolog interpreter. Arity Prolog programs can call routines written in other languages and vice versa. The manual includes examples in assembly language, Lattice C, Microsoft C, and Microsoft Pascal. Arity also sells supplementary packages of routines to implement SQL (structured query language) and to process data files created by Lotus 1-2-3 and Symphony.

The package consists of an interpreter, a compiler, and a **lint** (syntax) checker. Programs normally are developed in the interpreter, then compiled for production use. The user interface handles very much like Edinburgh Prolog, complete with a powerful interactive debugger similar to that of Prolog-2 (discussed below).

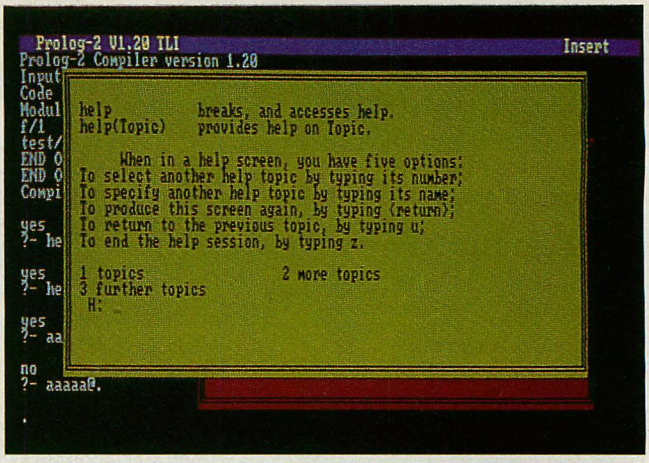
The interpreter can be configured to use any ASCII file editor that the user supplies. After editing a program, Arity Prolog automatically reloads the edited version of the program into the work space. A built-in predicate for saving the work space into a text file is included.

One editor, Borland's SideKick, *is* difficult to use. The Arity interpreter takes over the keyboard in such a way

PHOTO 1: *Arity Prolog Interface*

Arity Prolog offers the best overall implementation of the language; however, it lacks the more inviting windowed user interface of the other products reviewed here.

PHOTO 2: *Prolog-2 Interface*



Prolog-2 features on-line help and a complete (but complex) system of removable windows. A bewildering number of I/O predicates provide complete keyboard and screen control.

that SideKick will not start up normally (when called) if the interpreter is requesting input at the time. This can be circumvented by executing a do-nothing query such as **?-true.** so that the interpreter will give up control of the keyboard momentarily.

The compiler can be used in two ways: to generate .EXE files or to extend the interpreter by adding built-in predicates. Its user interface is similar to that of the Microsoft FORTRAN or C compilers: it accepts source file names on the command line and produces linkable .OBJ files. Compilation is surprisingly fast with this compiler (much faster, for example, than either Microsoft FORTRAN or C compilation.)

The stand-alone .EXE files are not quite self-sufficient, however. The product of compiling a program called ALPHA would be a set of files—ALPHA.EXE, ALPHA.IDB, and ALPHA.P00—all of which must be present for the program to run. Under some circumstances the program also may need a copy of its own source code (ALPHA.ARI) or the 8087 routines (CO.DRV). Arity Prolog would be much easier to use if more of this information could be consolidated into a single file.

Documentation. The Arity Prolog introductory booklet and the language reference manual are adequate, and the manual is much clearer than it was with the last version, but it still is much too concise to be helpful. Important pieces of information are mentioned once in passing, and the reader must search for them. For example, one step in compilation is barely mentioned: after each .EXE file is created, it must be run once to be initialized before the program can be executed. While it is being initialized, the program displays the message "Booting..." which seems to suggest that a catastrophic error has occurred. A different message, such as "Initializing...," or simply making this step transparent to the user would be better.

Language features. Arity Prolog supports all the features set forth in the Clocksin and Mellish standard text, *Programming in Prolog* (Springer-Verlag, 1984), reviewed along with another Prolog book in this issue on page 197. Arity has many PC-specific built-in predicates for invoking the DOS command shell, manipulating files, and managing directories. Arity offers extensive screen control, but no windowing (see photo 1).

This compiler includes several useful features for handling large programs. Collections of facts can be stored in special databases rather than in the program itself. These databases reside in files, not in memory, and they can be grouped into *worlds*. A program can use as many as 256 worlds, each containing 4MB, for a total of 1 gigabyte of data. The contents of each world can be made partially invisible to the other worlds, so that identical names can be used without conflict. Approximately 15 built-in predicates are available to manage the worlds and specify search schemes such as hashing and B-trees. This enables the user to specify an efficient method for sorting a large database. (Prolog-2 modules, discussed below, are similar to worlds.)

Arity handles character strings quite well. String searching, substring extraction, string concatenation, and string I/O are all supported. Predicates are provided to convert data from one type to another, so that atoms, strings, lists, integers, and floating-point numbers are interconvertible.

When a compiled program begins executing, it determines whether an 8087 or 80287 numeric coprocessor is present, and, if so, attempts to load the 8087 routines from the file CO.DRV. If either the coprocessor or the file is not found, the program performs floating-point arithmetic on the main processor. Unlike Prolog-2, Arity allows the use of transcendental functions, whether or not the coprocessor is installed.

This Prolog includes some novel extensions that help in the representation of procedural algorithms. These include **ifthen**, **ifthenelse**, and **case** statements, which behave much like their Pascal equivalents, plus two operators called *snips* that "cut out" unnecessary backtracking. Snips are an extension of the cut operator (!); backtracking is eliminated between the opening snip ([!) and the closing snip (!]). For example, in the program

```
goal(X) :-
    a(X),
    [! b(X,Y), c(Y) !],
    d(X).

test :- goal(X),write(X),fail.
```

the goal **test** will use all the alternative solutions for **a** and **d** but will not look for alternatives for **b** and **c**.

Interpreter/compiler compatibility. The Arity interpreter and compiler implement the same language, and programs can be ported between them easily. Arity Corporation also makes a lower-priced Standard Prolog Interpreter that implements all the predicates contained

in Edinburgh Prolog but not much else; however, it also is a proper subset of the full Arity Prolog language.

The **lint** utility scans an interpreted program to determine whether it can be compiled. It identifies unreferenced variables, noncontiguous predicate definitions, redefinitions of built-in predicates, undefined predicates, and other conditions that would interfere with compilation. Its error messages are generally clearer and more to the point than those issued by the Prolog-2 lint checker. And, compared to the dynamic error checking of Turbo Prolog, lint checkers are a real convenience. The user does not, for example, have to keep pressing F10 to allow compilation of uninstantiated variables.

Still, some minor differences do exist between the compiled and interpreted languages. For example, in the following program:

```
main :- p.
p:- q.
p:- s, assert(q).
s.
```

the compiler complains that no clauses are present for **q**, whereas in interpreted mode, the query **?-main.** executes successfully. The solution to this is to change the first clause for **p** to

```
p:- call(q).
```

This tells the compiler to look in the program database (to which clauses are added by **assert**) rather than in the executable code. Such a fine distinction, however, ought to be transparent to the user. (Arity plans to incorporate this facility into future versions.)

The ability to exchange data with Lotus 1-2-3 and Symphony is a major advantage for dealing with practical applications. Moreover, this is the only compiler for which the procedures for calling routines in other languages appear to have been completely fleshed out and documented. Arity Prolog's main weakness is its documentation. It is also high priced compared to compilers for conventional languages.

PROLOG-2

This product from Expert Systems International (ESI) comprises a powerful compiler, interpreter, and program development environment. It features modular programming facilities, a compiler, a **lint** syntax checker, a windowing system, a DEC-10-style interactive debugger, a structure editor, and a help facility. Although presently available only for the PC, a VAX/VMS version and a set of UNIX versions for various processors are under development, according to ESI. Expert Systems also markets Prolog-1, an interpreter, and ES/P Advisor, an expert system shell. (Despite its name, Prolog-2 has no relation to the Prolog II language that was recently introduced by Alain Colmerauer, the developer of Prolog.)

The Prolog-2 software comes on three 360KB diskettes and includes several demonstration programs among which is a very small LISP interpreter written in Prolog. According to the manual, Prolog-2 requires a PC, XT, AT, or compatible with 256KB of RAM to run the interpreter and 384KB of RAM to run the compiler. In practice, good results cannot be expected from Prolog-2 with anything less than a hard disk and 512KB of RAM.

As a development environment, Prolog-2 is large, full-featured, and easily customized, but rather slow. The version reviewed here, 1.21, takes about 55 seconds to start up from a hard disk. The manufacturer has said that version 1.3 will load much faster.

The slow start-up reflects the fact that the entire development environment is written in Prolog; this also

The Prolog-2 development environment is large, full-featured, and easily modified; it is slow because it is written in Prolog.

means that it is easily modified. At start-up, Prolog-2 reads initialization files that tell it which development packages to load. Normally, these include the compiler, editor, debugger, and on-screen help package, but they can be replaced with any Prolog routines.

Modular programming. The top-level user interface of Prolog-2 is very much the standard one: Prolog-2 types ?- and the user types a query (see photo 2). Error messages and debugging output appear in pop-up windows, and the compiler is invoked with the query **?- compile.** Compilation produces a .PRM file that can be linked into any Prolog program. Compiled modules cannot modify themselves, but a single program can consist of several modules, some compiled and some interpreted. In fact, modules also can be written in assembly language or other languages if certain conventions are followed. The examples in the manual, however, pertain only to assembly language.

This compiler is much slower than the others; even after compilation, its programs cannot run without the core interpreter. For a one-time license fee, the manufacturer provides a runtime interpreter, without the development environment, that can be used to deliver application programs to users.

Modules in Prolog-2 can make their predicates either visible or invisible to the other modules that constitute a program. Thus, during the development of a large program in many sections, name conflicts are not a problem.

Prolog-2 also allows programs to exceed available RAM by declaring modules to reside either in actual memory or in virtual memory (on a disk). Each of the maximum 256 virtual memory modules can hold 1MB. Modules can have various degrees of access, thus controlling the ability of other modules to modify them. Compiled modules normally offer no access, meaning they cannot be modified; interpreted modules can be designated for read, write, or read/write access.

Development environment. This environment provides a limited editor designed for making minor modifications to programs, but it is not suitable for writing complete programs. The best approach to editing with Prolog-2 is to use a pop-up editor such as SideKick. Other editors can be used by calling a DOS subshell (causing a 30-second delay) or by getting out of Prolog-2 and back into it again (losing more than a minute).

The most attractive feature of Prolog-2 is its interactive debugger, the high quality of which compensates for all the other minor inconveniences. This debugger resembles the DEC-10 Prolog debugger (as does Arity's debugger). It lets the user keep a fairly tight hold on the program being debugged. Once a "spy point" is encountered, the debug window is activated and the first goal of the current module is displayed. At this point 25 choices are available, including **l** (leap to next spy point), **f** (fail the goal), **r** (retry the goal), or **v** (solve the goal with user input).

This is a full-fledged interactive debugger with all the advantages of a mainframe implementation, and it can be changed easily. All the built-in predicates that control the execution of the program (**break**, **leap**, **skip**, **retry**, and so on) are available to the programmer.

Language features. The Prolog-2 language is a superset of Edinburgh Prolog, except for one major difference: a char-

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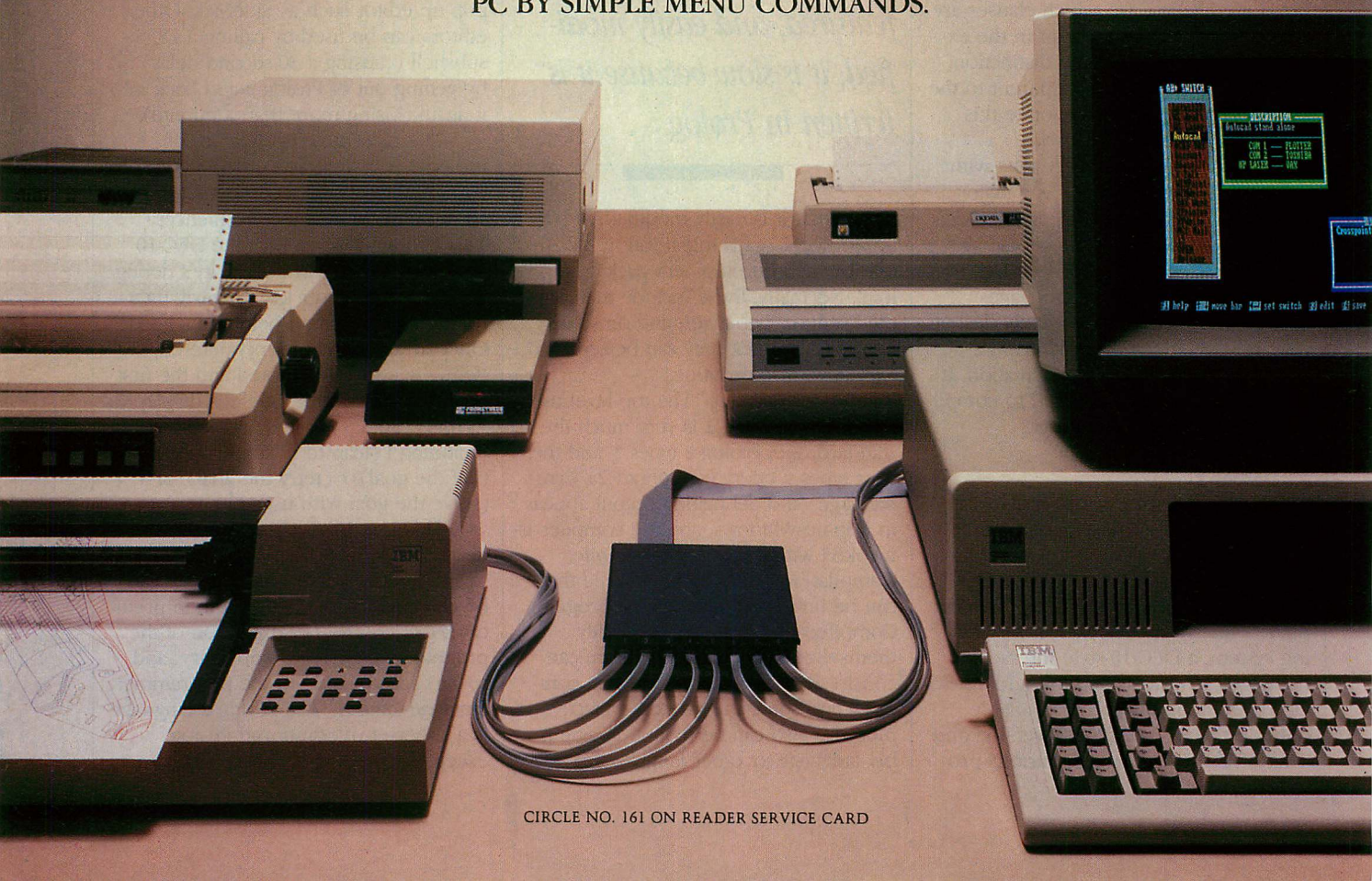

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acter string is considered a type rather than a list of ASCII codes. Although it is not standard, this is a good feature because it greatly reduces the amount of memory needed to hold strings. A useful set of string-handling functions is built in. Strings can be concatenated and converted to and from lists, atoms, or integers; substrings can be searched, deleted, or inserted.

Other data types include lists, atoms, clauses, integers, and reals. An 8087 or 80287 is used if present; however, the transcendental functions (trigonometric, hyperbolic, logarithmic, exponential, and square root) cannot be used without a coprocessor.

The predicate **command** invokes the DOS command shell and, optionally, passes a command to it. Unlike other implementations, Prolog-2 saves the current state of the machine to disk (if space is available) and frees up most of the RAM it was using before invoking COMMAND.COM. This process takes about 25 seconds on an AT.

Prolog-2 permits a high degree of control over keyboard input and screen output, including a system of removable windows. The Prolog-2 windowing system is complete and flexible, but when compared with Turbo Prolog, it seems complex and difficult. To perform I/O in a window, the user must call a bewildering number of built-in predicates from a set of 20. Once created, opened, and made visible, windows can be controlled in many ways. The user can even perform limited full-screen editing while typing input into a window.

The high degree of flexibility offered by Prolog-2 is evidenced in the token compiler, which lets the user change the basic syntax of the language: I/O procedures that normally would use Prolog syntax can use any syntax the user designates. If exploited to the fullest, the token compiler provides an elegant way to make programs accept input in special symbolic notations, chemical formulas, for example, or even a subset of English. The input to the token compiler is a formal grammar consisting of state tables, character-class tables, and various processing routines; the token compiler transforms this grammar into executable code.

At about 500 loose-leaf pages, the manual for Prolog-2 looks like a manual for a mainframe product. It provides reference material only, however—no tutorial component—and although reasonably well written, it could be improved. For example, the list of built-in predicates is incomplete: most of them appear in chapter 13, and several more in the index, but a few, such as mode, are not listed at all. The catalog of error messages in appendix A shows only the messages themselves, with no explanation of the errors. Even as it stands, this compiler is better documented than Arity Prolog or Turbo Prolog.

Installation and use. Version 1.21 is copy protected and can be installed on a maximum of three floppy-disk systems and/or two hard-disk systems. (The manufacturer plans to drop copy protection in version 1.3.)

Prolog-2 has a few bugs. The error handler sometimes runs into a memory limit, and goes into a message-writing loop that can be stopped only by rebooting. The predicate **command** (for invoking the DOS shell) sometimes reports an error allocating memory. ESI has indicated that these bugs will be fixed in a later release.

Overall performance. The major strengths of Prolog-2 are its power and flexibility: with an Edinburgh-type user interface, its on-screen help, a powerful interactive debugger, and a wide range of built-in predicates. The cost of all this is slowness in many areas of operation, especially start-up and compilation.

The flexibility of Expert Systems' Prolog-2 can be seen in its token compiler, which lets the user change the basic Prolog syntax.

This slowness is an indication that Prolog-2 was designed for portability (and not just for the PC). Large portions of the system are written in Prolog itself. The windowing system in particular isolates the programmer from the hardware (to an annoying degree).

Another Prolog-2 limitation is that to deliver compiled application programs requires a runtime interpreter, which must be purchased from Expert Systems. Moreover, Prolog-2 has a severely limited recursion stack—insufficient to reverse a 70-element list. Some algorithms may not work.

Prolog-2 faces stiff competition from Arity Prolog for use on the PC. At present, Prolog-2 is recommended only for developing programs that will be ported to the VAX or some UNIX systems when the appropriate versions of Prolog-2 become available.

TURBO PROLOG

Two years ago, Borland's Turbo Pascal compiler (for $49.95) took the PC world by storm and drove several competitors right off the market. Prerelease advertising led many to expect Turbo Prolog would do the same. At $99.95, it is about one-tenth the price of its competitors, and it promised astonishingly fast program execution.

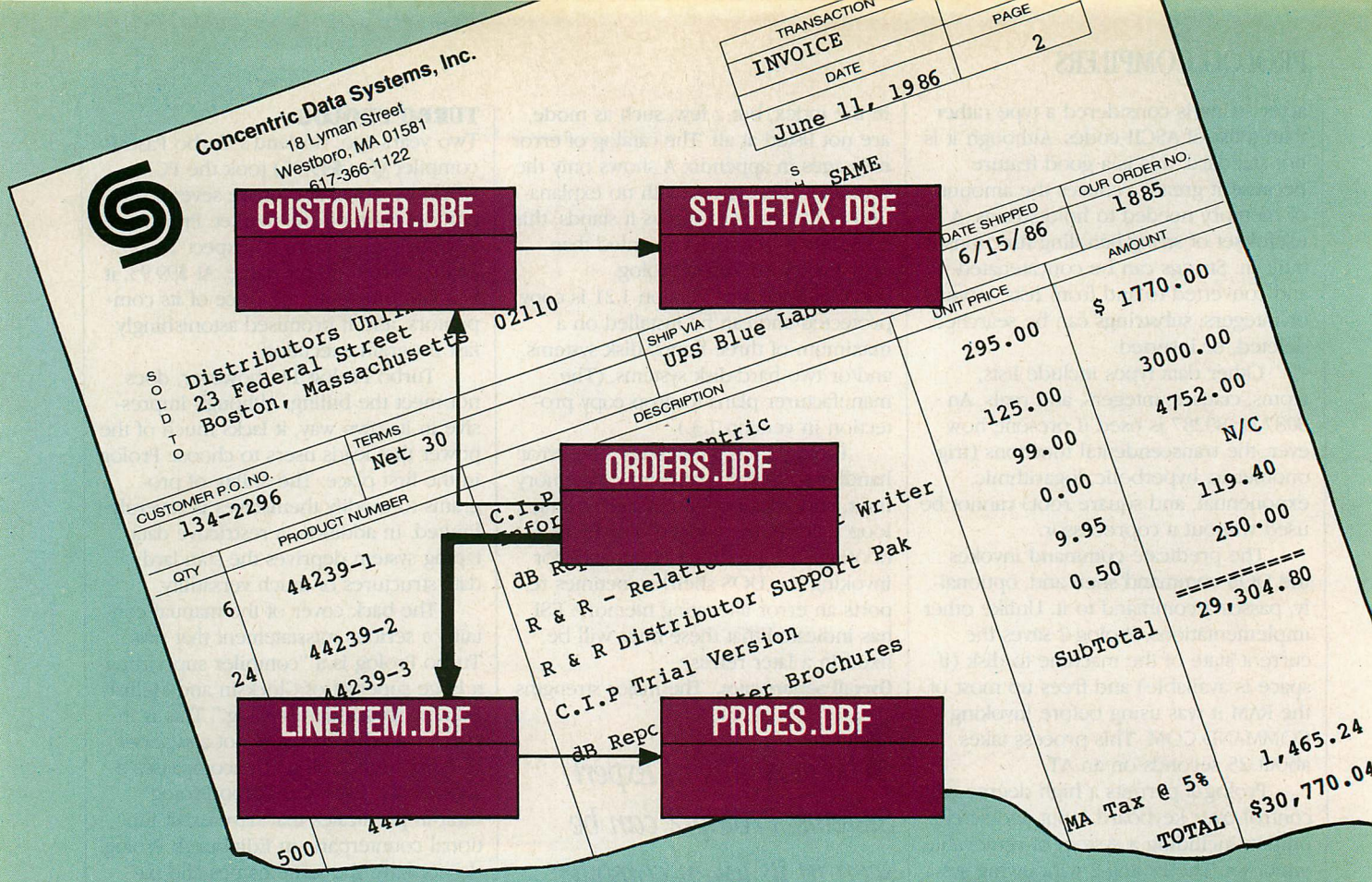
Turbo Prolog 1.0, however, does not meet the billing. Although impressive in its own way, it lacks much of the power that leads users to choose Prolog in the first place. The ability of programs to modify themselves is severely limited. In addition, a restrictive data typing system deprives the standard data structures of much versatility.

The back cover of the manual contains a serious misstatement that says Turbo Prolog is a "compiler supporting a large superset of Clocksin and Mellish Edinburgh standard Prolog." This is incorrect. Turbo Prolog is not a *superset* of Edinburgh Prolog; it encompasses a *subset* only. Even the Turbo Prolog built-in predicates that have exact functional counterparts in Edinburgh Prolog do not have the same names and parameters in most cases. It is even difficult to port programs from other versions of Prolog into Turbo Prolog and vice versa because of the extensive syntactic and semantic differences. (According to Borland, a future release of the product will be more compatible with the Edinburgh standard.)

Language restrictions. The most obvious difference between Turbo Prolog and other Prologs is that Turbo requires the programmer to declare the types of all data items. Data typing itself is not a bad practice: the strong typing system of Pascal, for example, makes debugging easier. Moreover, the type declarations of Turbo Prolog greatly increase execution speed. However, some of the data structures traditionally used in Prolog and LISP are almost impossible to create in Turbo Prolog.

The most serious restriction is that all the elements of a list must be the same type. The list **[1,2,3]** is permissible, as is **[go,stop]**, but **[1,2,3,go]** is not permitted. To some extent, the user is able to work around this by creating a list of structured items that have type markers attached to them, such as **[int(1),int(2),int(3),symbol(go)]**, however, this notation process becomes cumbersome quickly.

This situation is particularly awkward in the creation of a list in which some members are individuals and some are lists. Such structures are used



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to represent parse trees in natural language processing programs. For example, the sentence

The dog chased the cat

might be analyzed as

[[the,dog],[chased,[the,cat]]]

to show how the words form syntactic groups. The best way to represent this sentence in Turbo Prolog is

```
s(np(det("the"), n("dog")), vp(v("chased"),
np(det("the"), n("cat"))))
```

The same representation can be used in standard Prolog. The difference is that in order to create this data structure, Turbo Prolog requires a complex set of type declarations:

```
domains
  sentence     s(nounphrase,verbphrase)
  nounphrase   np(noun) ; np(det,noun);
               np(noun,prepphrase);
               np(det,noun,prepphrase);
               np(det,adj,noun);
               np(det,adj,noun,prephrase);
               np(adj,noun);
               np(adj,noun,prepphrase)
  verbphrase   vp(verb);
               vp(verb,nounphrase)
  noun         n(symbol)
  verb         v(symbol)
  ...(etc)
```

All possible structures must be anticipated and described in the type declarations. In effect, the entire formal grammar must be stated twice: once in the type declarations, to indicate the kinds of data structures that may be created, and again in the parsing algorithm that actually creates them. (Turbo Prolog obviously does not incorporate the Clocksin and Mellish *grammar rule notation* and the built-in parser that accompanies it; Arity Prolog and Prolog-2 both do.

Another major restriction is that **call** is not present at all, and **asserta**, **assertz**, and **retract** apply only to facts (rules that do not contain an **if**). To use **asserta**, **assertz**, and **retract**, the programmer must create a database. Although a database offers the advantage of not consuming RAM, it forfeits the logical power of Prolog because it cannot contain rules of inference. A Turbo Prolog program has no direct method to add a rule of inference to itself as it runs, nor to execute a query that was created by computation.

Full-featured. Apart from these limitations and flaws, Turbo Prolog is a full-featured product. Its greatest strength is in I/O where it gives the programmer full control of the PC's hardware capabilities. A Turbo Prolog program is able to perform any interrupt, examine or alter any memory location, and communicate directly with I/O ports. These features make Turbo suitable for tasks in which most Prologs would require machine-language subroutines.

Screen and keyboard I/O are handled by a system of removable windows. Initially, the program has control of the whole screen (or the dialogue window if running in the development environment). Additional windows can be created and written to, then removed. Windows can be shifted from foreground to background without removing them.

The program can create edit windows that access the facilities of a WordStar-like editor. Edit windows may start out empty or they may contain text supplied by the program. When the user finishes editing, the entire text is delivered to the program as a single character string containing line terminators. Predicates are available for concatenating strings and taking them apart, and for converting strings to and from integers and reals, and lowercase to uppercase. Keyboard assignments for editing cannot be reconfigured.

Using Turbo. An especially noteworthy feature of this compiler is its excellent eight-lesson tutorial. It is designed specifically for Turbo Prolog and assumes no knowledge of logic programming or AI on the part of the user. All of the example programs from the manual are supplied on disk, together with a simple natural language query system called GEOBASE that can be modified to incorporate the user's data.

Turbo Prolog requires extensive type declarations and alterations of syntax because it implements a very limited subset of Prolog.

Turbo Prolog requires 384KB of RAM, but its compiled programs often will run in 256KB or less. It is practical to run Turbo from a floppy-disk system, although automatic one-step creation of .EXE files (see below) may be difficult without a hard disk because LINK.EXE, COMMAND.COM, and several other files all must be accessible simultaneously.

The Turbo Prolog development environment is similar in spirit to Turbo Pascal but considerably more sophisticated. The screen is divided into an edit window, a dialogue window (for execution), a message window, and a trace window. Initially, these are small and nonoverlapping (see photo 3), but the user can make them larger, whereupon the most recently written window automatically comes to the foreground.

The user types the program in the edit window (where limited on-screen help is available), then presses Esc-C to compile it. Compilation is very fast, and the compiled code is normally placed in memory for immediate execution, just as it is in Turbo Pascal. The user can choose to put the compiled code in a .OBJ file for linking with routines in other languages or to compile and link to produce a .EXE file immediately. The resulting .EXE files are relatively small (on the order of 60KB to 70KB for a short program). The .OBJ files produced by version 1.0 of Turbo Prolog, however, are not compatible with version 2.1 of the PC-DOS linker. Turbo 1.1 has its own linker, one that is considerably faster than DOS LINK; however, DOS LINK 2.14 still can be used, if the user desires.

The trace window permits stepping through the execution of a program but it offers nothing close to the versatility of either the Arity or the Prolog-2 debuggers. As with the standard Prolog debugger, a predicate's entry, success or failure, and re-entry through backtracking can be traced. But Turbo offers no commands for altering the path of execution interactively. On the other hand, Turbo Prolog does place the cursor of the edit window on the predicate of the port on the trace window. This is especially helpful with recursive procedures to see exactly where the trace is within the program.

Turbo Prolog programs can call subroutines written in any language that can be compiled into Microsoft-style .OBJ files, including assembly language, C, FORTRAN, and Pascal. Current versions of Turbo Pascal do not produce .OBJ files and therefore cannot be used. The Turbo Prolog manual indicates that .OBJ file support will be incorporated into Turbo Pascal 4.0, scheduled for release in early or mid-1987.

Graphics. Turbo Prolog supports graphics on the IBM Color Graphics Adapter (CGA) and Enhanced Graphics Adapter (EGA), with conventional dot-and-line graphics and turtle graphics. Turbo has its own coordinate system in which points on the screen are numbered from 0 to 31,999 both vertically and horizontally; these coordinates are

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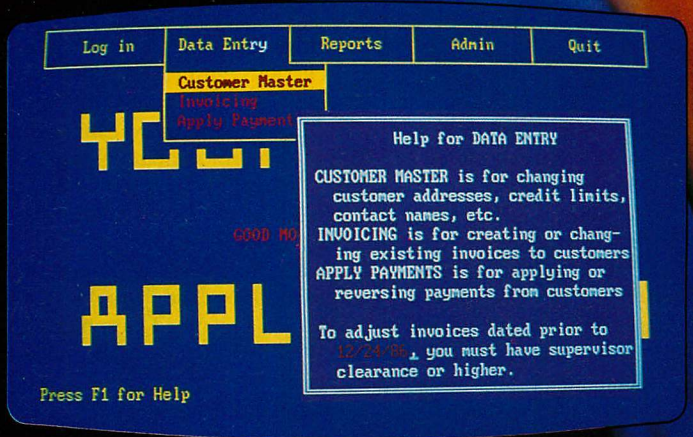

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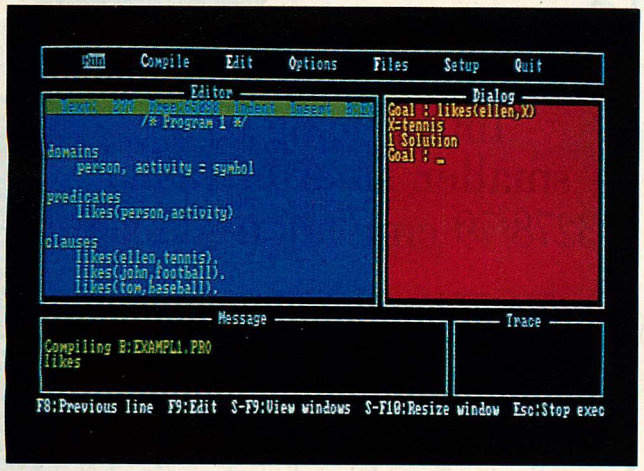
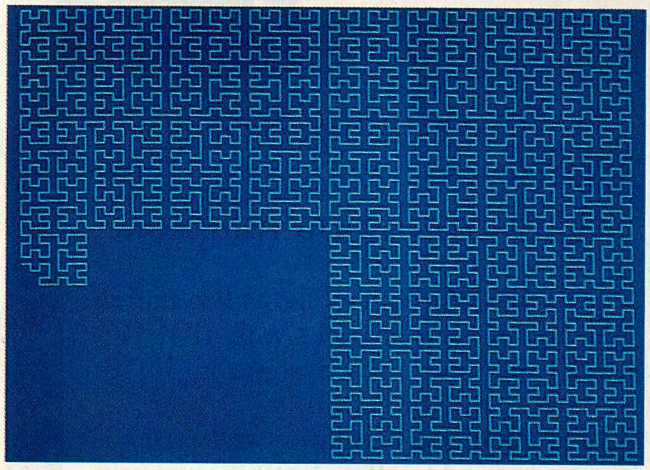
PHOTO 3: *Turbo Prolog Interface*



Turbo Prolog's user interface is one of the best ever developed. The four main windows are supplemented by pop-up windows for a notably smooth operation. The window system operates easily under user or program control.

PHOTO 4: *Turbo Prolog Hilbert Curve*



The declarative, modular nature of Prolog combined with Turbo Prolog's EGA and turtle graphics support produces a very rich graphics environment. HILBERT.PRO (listing 7), which produces this curve, is surprisingly short and clear.

translated into appropriate values for the graphics adapter in use. This is an elegant way of making graphics algorithms hardware-independent while keeping the speed of integer arithmetic.

Prolog is a particularly good language for turtle graphics because most classic turtle-graphic algorithms make heavy use of recursion. HILBERT.PRO (listing 7), which draws a Hilbert curve, is an example (see photo 4); this program is much shorter than comparable programs in most languages.

Overall performance. Turbo Prolog exhibits some important capabilities: it offers fast compilation and execution, its powerful low-level interface to the hardware and operating system is quite advanced, its user interface is state-of-the-art, and its tutorial-style manual is truly helpful (not to mention its low price).

As a recursive programming language with a structure derived from logic programming, Turbo Prolog is first rate. If it were not called Prolog, it might receive uncompromised high marks. However, Turbo Prolog is missing the powerful features that all other AI languages have had. AI technology relies on the ability of programs to examine and modify themselves and to create dynamic data structures without type restrictions. Because it lacks these features, Turbo Prolog can be placed in the same class with FORTRAN, Pascal, and C, but not with other Prolog and LISP implementations.

The low price and fine manual would make Turbo Prolog attractive as an instructional tool, except that the language taught is not standard Prolog. A better way to learn Prolog would be to buy a low-priced interpreter that follows the Edinburgh standard.

THE FUTURE...PROLOG?

Prolog is coming into its own on the PC. A year ago, the only available implementations were excellent for instructional or experimental work, but not powerful enough for serious application programs. Now, an AT running one of the compilers reviewed here can compete with minicomputers and high-performance workstations.

The ideal Prolog compiler would combine the language and performance of Arity with the flexibility of Prolog-2 and the windowing, graphics (and lower price) of Turbo Prolog. If nothing else, Turbo may help to drive down the price of its competitors: at a time when Pascal and BASIC compilers range from $50 to $100, and some C compilers are closer to $25, users may not be willing to pay $800 for the so-called language of the future.

Turbo Prolog is a superior product in graphics, windowing, and hardware interfacing, but as noted, it implements an intrinsically less powerful language. If in future versions Borland's Turbo Prolog is restored to the full power of the language, it, too, could be highly recommended for its speed and control of the PC.

Although Prolog-2 has windowing, on-screen help, and an extremely flexible environment, it is relatively complicated, slow, and it is a clumsy product with which to work.

Cost considerations notwithstanding, Arity Prolog is the best of the three for serious application programs. The Arity Prolog language is a true superset of Edinburgh Prolog, its compiler produces fast executable code and, on the whole, the development environment is well adapted to the PC.

REFERENCES

Kluzniak, F. and S. Szpakowicz. *Prolog for Programmers.* London: Academic Press, 1985.

Sterling, L. and E. Shapiro. *The Art of Prolog.* Cambridge, MA: MIT Press, 1986.

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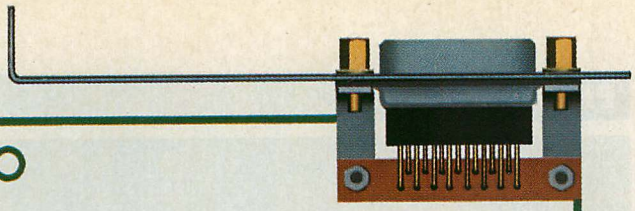
Michael Covington, Ph.D., and Andre Vellino are researchers, working separately with Prolog, at the Advanced Computational Methods Center, University of Georgia.



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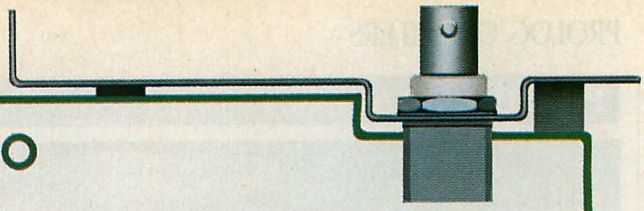

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LISTING 1: ONERULE.PRO

```
/* 30,000 logical inferences */
f(X) :- Y is X-1,
        Y > 0,
        f(Y).
/* Initial goal: ?- f(10000). */
```

LISTING 2: TAIL.PRO

```
f(X) :- write(X), nl,
        Y is X+1,
        f(Y).

test :- f(1).
```

LISTING 3: CENTER.PRO

```
f(X) :- write(X), nl,
        Y is X+1,
        f(Y),
        write(Y), nl.

test :- f(1).
```

LISTING 4: CENTERT.PRO

```
/* adapted for Turbo Prolog */
predicates
  f(integer)
  test
clauses
  f(X) :- write(X), nl,
          Y=X+1,
          f(Y),
          write(Y), nl.
  test :- f(1).
goal
  test.
```

LISTING 5: REVERSE.PRO

```
/* Number of logical inferences = (N**2 + N)/2 + N + 1,  */
/* where N is the number of elements in the list.        */
/* In this case N = 256, so there are 33,153 inferences. */

reverse([],[]).
reverse([X|Y],Z) :- reverse(Y,Y1), append(Y1,[X],Z).

append([],X,X).
append([X|Y],Z,[X|W]) :- append(Y,Z,W).

/* Generate a 256-element list and then reverse it       */

test :- write('Generating test data...'), nl,
        List8 = [aa,bb,cc,dd,ee,ff,gg,hh],
        append(List8,List8,List16),
        append(List16,List16,List32),
        append(List32,List32,List64),
        append(List64,List64,List128),
        append(List128,List128,List256),
        write('Start...'), nl,
        reverse(List256,Result),
        write(Result), nl.
```

LISTING 6: SRCHBACK.PRO

```
/* Number of inferences = 2**(N+2) - 2  */
/* where N is largest number-word used. */
/* 32,766 inferences in this example.   */

true1.
true2.

one(a):- true1.
one(b):- true2.
two(X) :- true1, one(X).
two(X) :- true2, one(X).

three(X) :- true1, two(X).
three(X) :- true2, two(X).
four(X) :- true1, three(X).
four(X) :- true2, three(X).
five(X) :- true1, four(X).
five(X) :- true2, four(X).
six(X) :- true1,  five(X).
six(X) :- true2,  five(X).

seven(X) :- true1, six(X).
seven(X) :- true2, six(X).
eight(X) :- true1, seven(X).
eight(X) :- true2, seven(X).

nine(X) :- true1, eight(X).
nine(X) :- true2, eight(X).
ten(X) :- true1, nine(X).
ten(X) :- true2, nine(X).

eleven(X) :- true1, ten(X).
eleven(X) :- true2, ten(X).
twelve(X) :- true1, eleven(X).
twelve(X) :- true2, eleven(X).

thirteen(X) :- true1, twelve(X).
thirteen(X) :- true2, twelve(X).

test :- thirteen(X),fail.
```

LISTING 7: HILBERT.PRO

```
predicates
  turn(symbol)
  opposite(symbol,symbol)
  hilbert(symbol,integer,integer,integer)
  two_to_the(integer,integer)
clauses
  turn(left)  :- !, left(90).
  turn(right) :- !, right(90).
  opposite(left,right).
  opposite(right,left).
  hilbert(_,Order,MaxOrder,_) :-
    Order = MaxOrder,
    !,
    left(180).
  hilbert(Sense,Order,MaxOrder,SegSize) :-
    !,
    NewOrder = Order + 1,
    opposite(Sense,OppSense),
    turn(Sense),
    hilbert(OppSense,NewOrder,MaxOrder,SegSize),
    turn(Sense),
    forward(SegSize),
    hilbert(Sense,NewOrder,MaxOrder,SegSize),
    turn(OppSense),
    forward(SegSize),
    turn(OppSense),
    hilbert(Sense,NewOrder,MaxOrder,SegSize),
    forward(SegSize),
    turn(Sense),
    hilbert(OppSense,NewOrder,MaxOrder,SegSize),
    turn(Sense).

  two_to_the(0,1).
  two_to_the(Exponent,Result) :-
    !,
    N = Exponent-1,
    two_to_the(N,R),
    Result = R+R.

goal
    write("Enter desired order (1-10):"),
    readint(MaxOrder),
    two_to_the(MaxOrder,N),
    SegSize = 24000 / N,
    clearwindow,
    graphics(2,0,2),
    penpos(30000,30000,180),
    hilbert(left,0,MaxOrder,SegSize),
    write("Press RETURN..."),
    readln(_),
    text.
```

LISTING 8: CUTTEST.PRO

```
test0 :- not(not(!)), fail.
test0 :- write('Cut in Not does not act').
```

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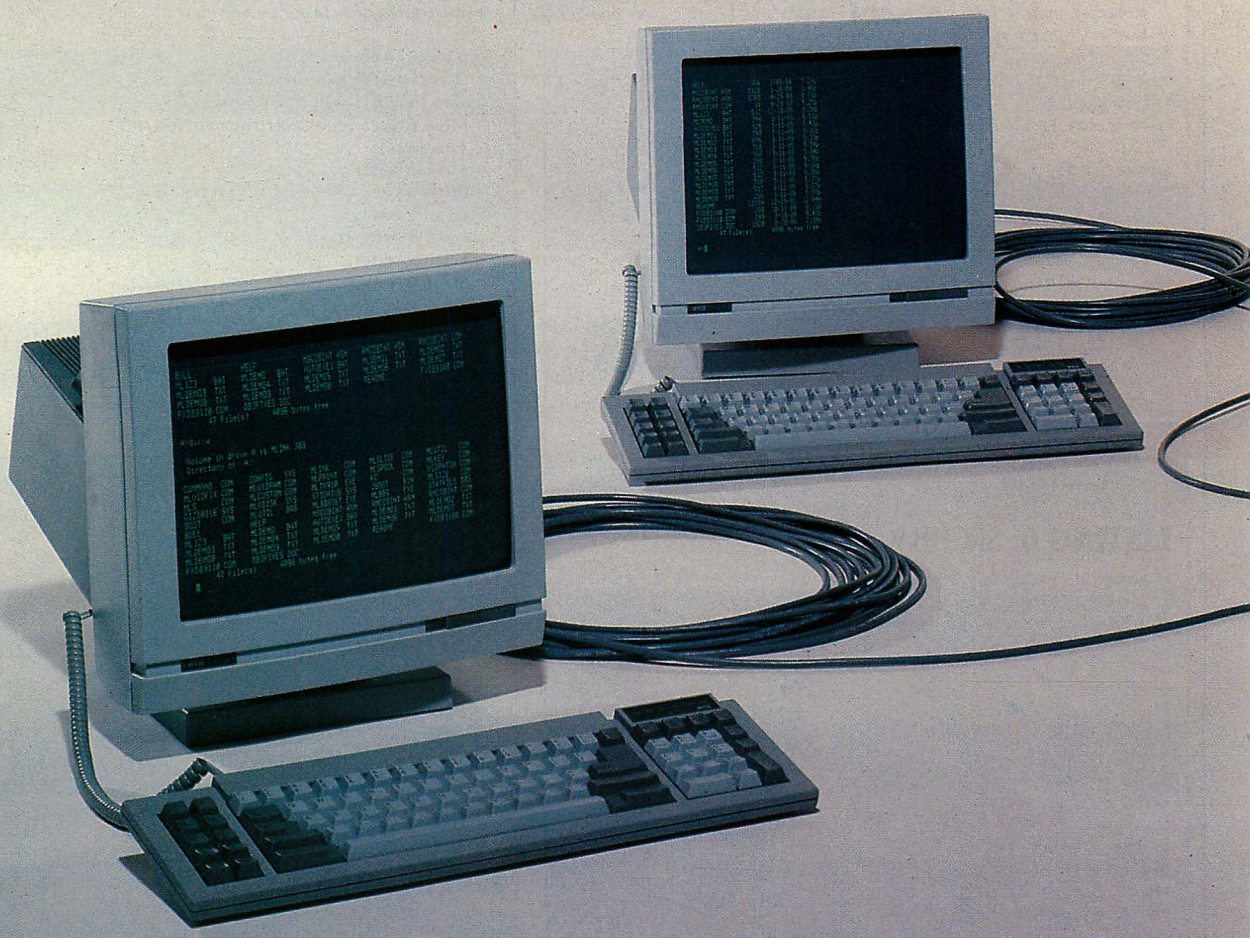

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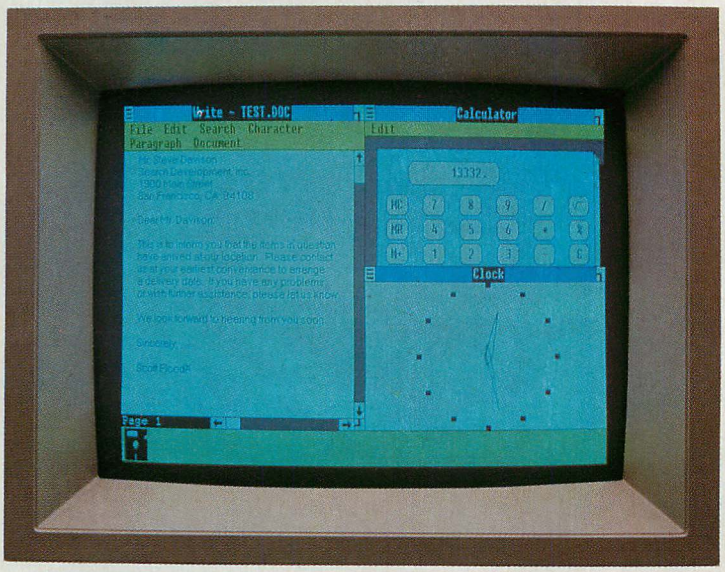
–66K, –128K, –128K. A word of warning: Too many pop-ups can have a negative effect on your memory.



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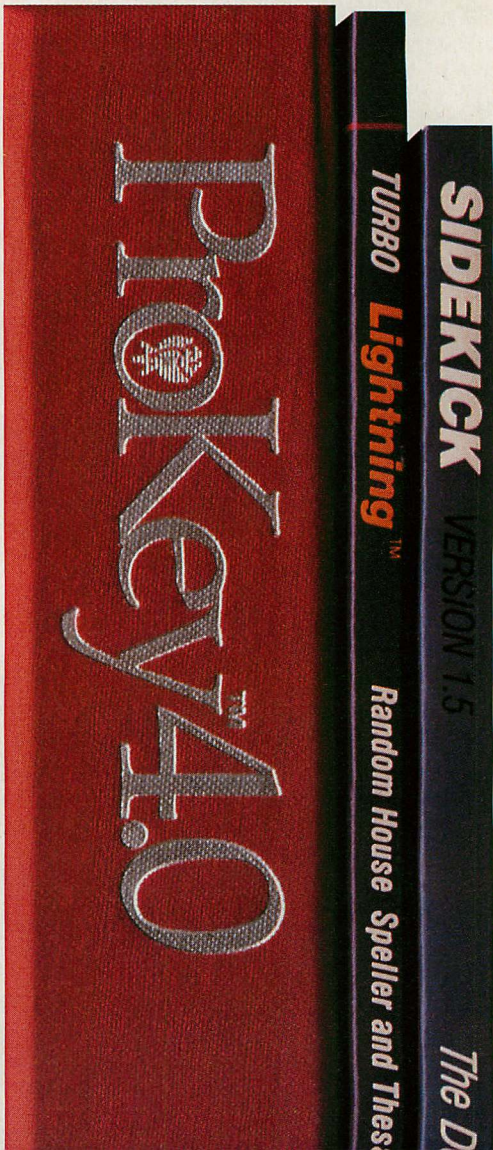
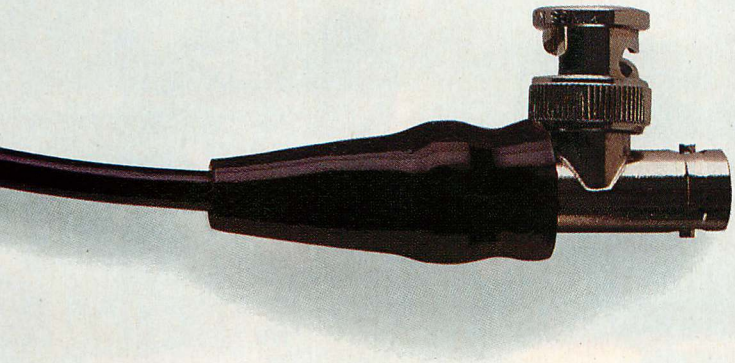


mory is first to go.



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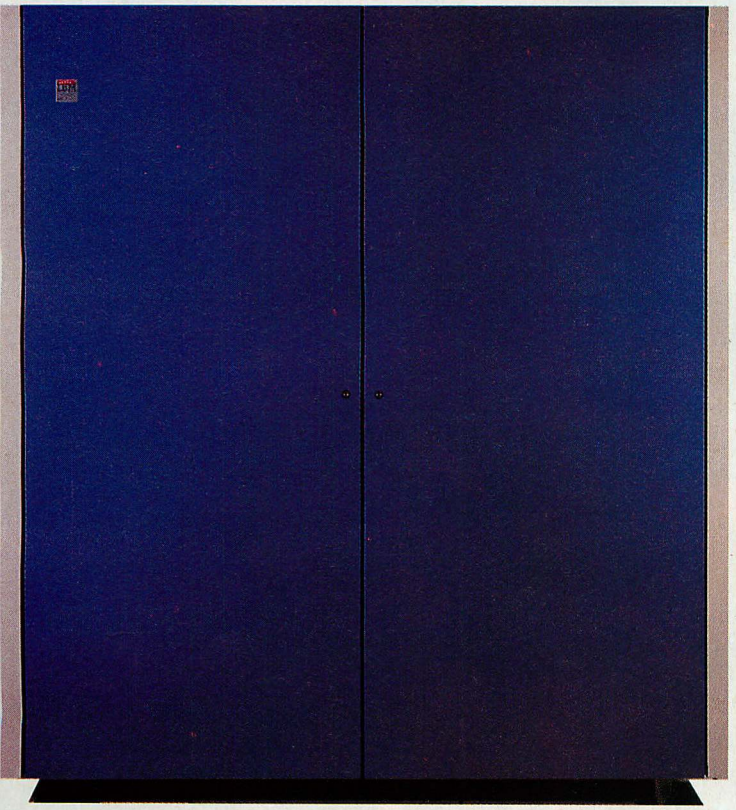

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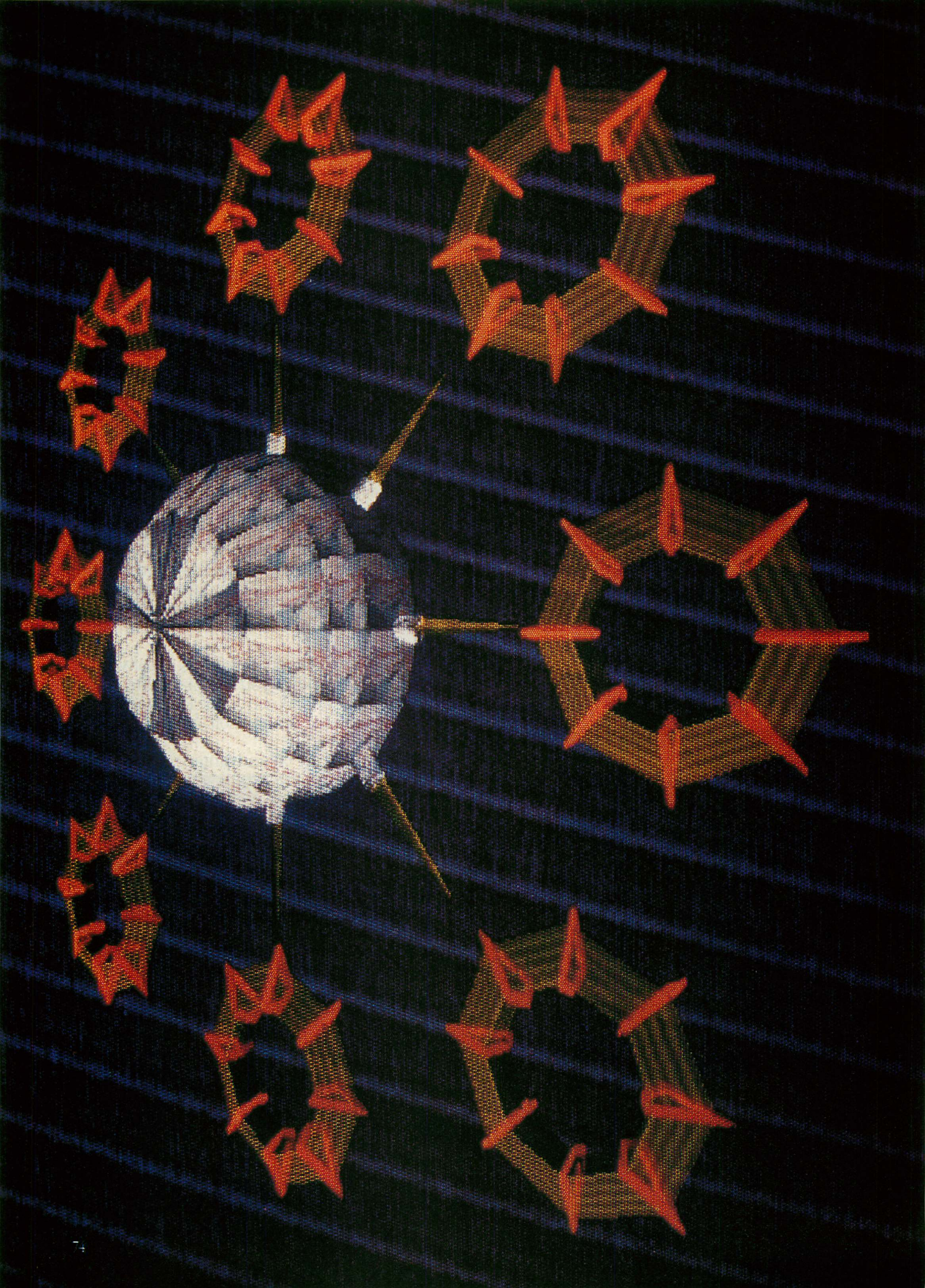

LAN Gateways

As the versatile PC becomes integrated into mainframe environments, connectivity is a vital issue. The four LAN gateways reviewed here provide a means of managing this potentially complex and costly undertaking.

ART KRUMREY and ROGER ADDELSON

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Traditionally, IBM mainframe users have communicated with their host systems via bisynchronous or SNA (System Network Architecture) communications networks using the 3270 family of terminals. With the increased presence of the PC in the corporate environment, users want to use its individual resources and continue to connect to the mainframe. Although this seems to suggest a need for two devices, the trend today is the multipurpose workstation, with the PC providing both local personal computing resources and emulation of a 3270 terminal. This arrangement also enables users to transfer files between the PC and the host mainframe.

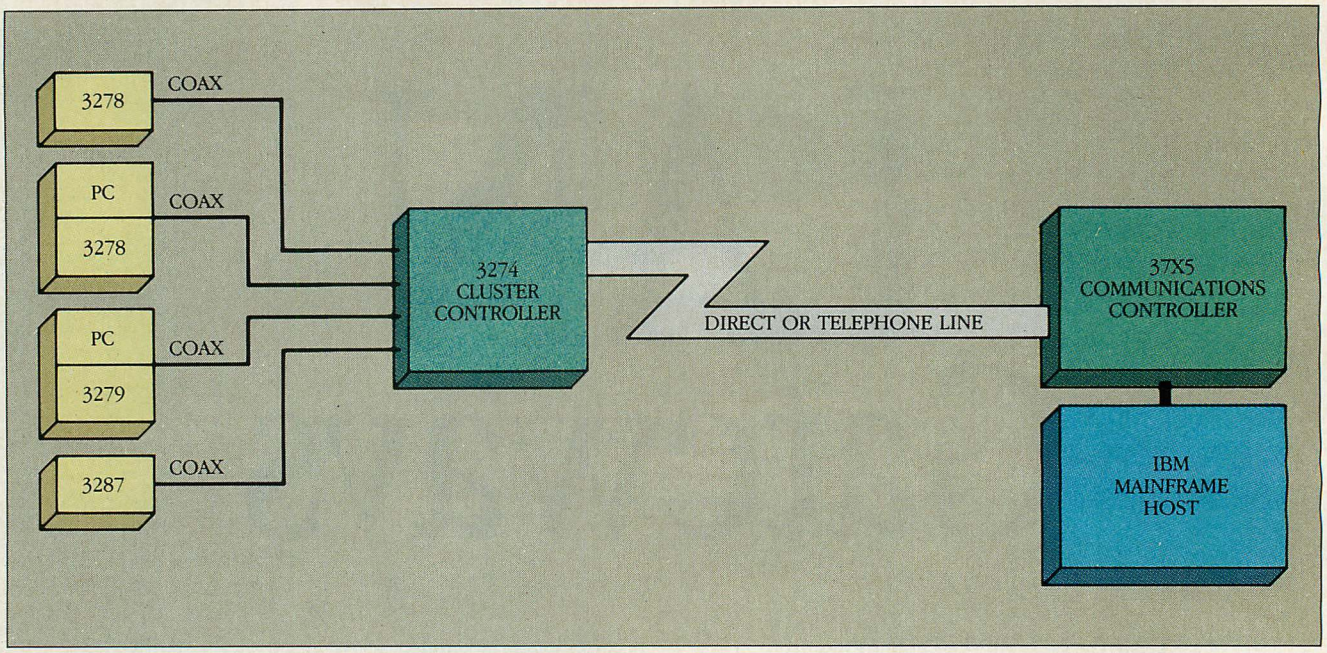
One of the more versatile methods of achieving this connection is within a local area network (LAN), with one PC serving as the "gateway" to mainframe connections. Four such LAN gateway products are reviewed in this article: PCOX/GATEWAY from CXI, Inc.; NAS Single Board Solution, marketed by Novell, Inc. and Quadram Corporation; netPATH SNA-3270 from Pathway Design; and the IBM 3270-PC Emulation. The first three packages were reviewed because they run on Novell's NetWare. (For a review, see "NetWare in Control," Art Krumrey, November 1985, p. 102.) The IBM product, which runs on the IBM PC Network, was included as a point of reference.

The IBM 3270 protocol is well established as the best way for a terminal to interact with a mainframe. The IBM SNA generalizes and formalizes this interaction, defining the protocol into layers. In early 3270 products, the layers seemed an unnecessary complication to bisynchronous communication; critics even suggested that it was all a ploy to sell unnecessarily fast processors. However, the increasing intelligence of devices that act as 3270 terminals demonstrates the value of the layered protocol—distributing the function of each layer at the optimal intelligent component in the terminal data path.

A PC can communicate with a mainframe using SNA and the 3270 protocol in a variety of ways:

- by emulating an asynchronous terminal that is connected to a 3270 protocol converter.
- by emulating a terminal that is connected to a minicomputer, such as an IBM System/36, running an IBM 3274 cluster controller emulator along with other applications.

FIGURE 1: *Typical 3270 Communications Configuration*



IBM 3270 terminals and PCs emulating 3270 terminals communicate with the host mainframe via a cluster controller.

- by emulating an IBM 3278/79 terminal that is connected to an IBM 3274/76 cluster controller by a coaxial cable (see figure 1).
- by emulating an IBM 3278/79 terminal and a 3274/76 controller that is connected to the IBM mainframe communications controller.
- by emulating one or more 3278/79 terminals through a PC LAN with one PC on that network acting as a 3274/76 cluster controller connected to the IBM mainframe communications controller. This PC is called the *gateway* (see figure 2).
- by emulating one or more 3278/79 terminals through a PC LAN, with one PC on that network connected to a 3274 cluster controller equipped with a distributed function terminal (DFT) port that allows multiple sessions. Up to five PCs on the network then can access the mainframe. This PC also is a gateway (see figure 3).

The best arrangement for a particular situation depends mainly upon the connections that are already in place. If a coaxial line is available because a PC is replacing a "dumb" terminal, it is an obvious choice. If access to a mainframe-connected minicomputer also will be needed, it is best to use that connection to the mainframe. If PCs are connected by a LAN, the local network can be used to connect to the mainframe. Indeed, the LAN gateway is emerging as a cost-effective, versatile means of mainframe access. The intelligence of the various components that make up a gateway will use the full potential of SNA structure to support features such as peer-to-peer communications of application programs running on PCs on the network with application programs running on mainframes, minicomputers, or other PCs.

Cost is another pertinent factor for consideration. Incorporating 3270 emulation hardware and software into each PC, as in figure 1, costs about $1,000 per PC and about $16,000 for a 3274 cluster controller (one for every 32 terminal devices). Installing a mainframe gateway on a LAN, as in figures 2 and 3, requires a software investment of about $2,500 for 16 PCs ($150 per PC), and $2,000 for a PC that acts like a dedicated gateway server, with a special SDLC card or 3278/79 adapter. This is most cost-effective if the LAN is already in place. Depending upon the number of workstations needed, it also may be a good time to connect via network any freestanding PCs and secure a mainframe connection at the same time.

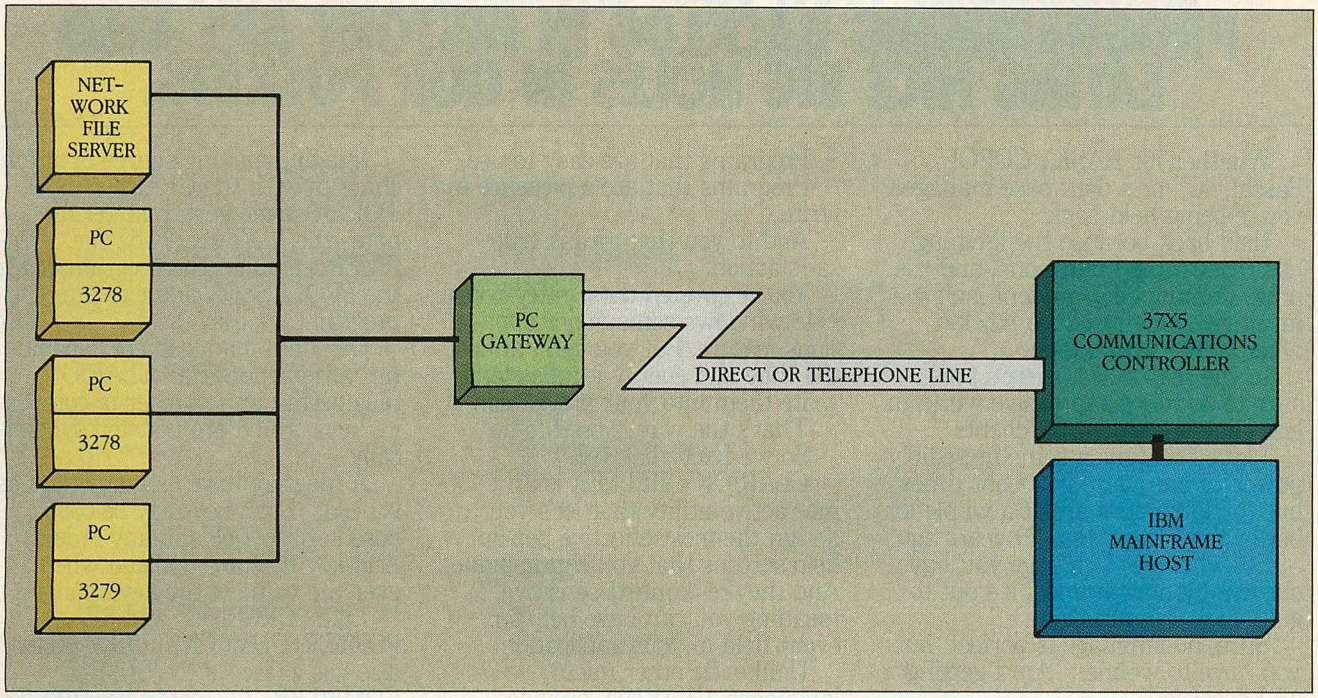
The 3270 Information Display System, as it is formally called, is an intelligent terminal that communicates with the IBM mainframe via a local cluster controller (model 3274 or 3276) and a communications controller (model 3725 or 3705) located at the host site (figure 1). Another configuration, not relevant to this article, finds the cluster controller directly channel-connected to the mainframe.

The 3270 terminal is called *intelligent* because it interprets and executes many of the display functions locally, such as cursor movement, insertion and deletion of text, and character color and intensity. When it is used in conjunction with the cluster controller, the 3270 is a full-screen device in that it does not send just a character or a line at a time to the host, but collects and transmits or receives an entire screen or transaction (block of data).

The cluster controller takes the block of data from the 3270 terminal (or PC emulating a 3270), adds the terminal ID so the host can determine the origin of the transmission, formats the block and adds the SNA or bisynchronous protocol, and sends the data to the communications controller. The cluster controller can have as many as 32 3270-type devices (terminals and printers) connected. Typically, the cluster controller communicates with the communications controller via special modems over dedicated telephone lines. Several controllers may be *multidropped* (connected to one phone line).

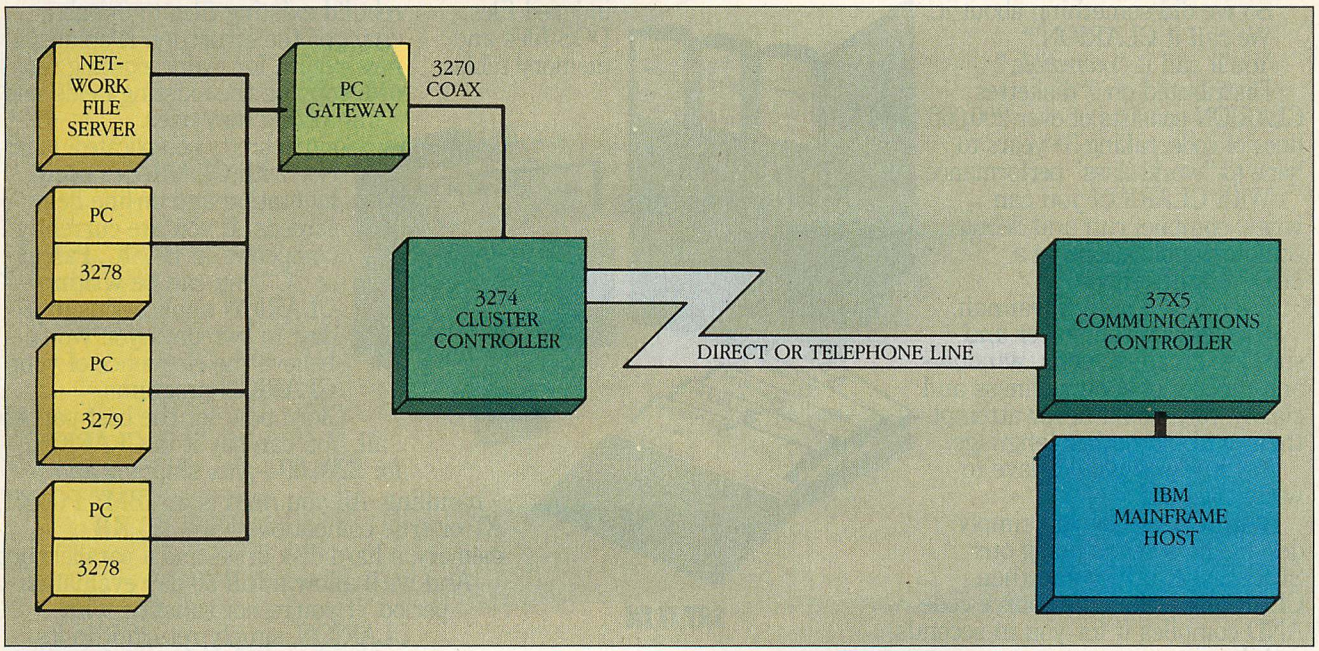
The communications controller, on the other end of the telephone line, may have many cluster controllers connected to it. Each cluster controller connection is called a *line*. When the communications controller receives a block of data, it adds the line ID to the block, and forwards it to the host. The host uses the line and terminal IDs to identify each user session.

FIGURE 2: *LAN with 3270 Gateway SDLC Connection*



PCs communicate with the mainframe via a gateway PC that communicates directly with the host's communications controller.

FIGURE 3: *3270 Gateway Connected to Cluster Controller*



Here, PCs communicate with the host mainframe via a gateway PC that is connected to the host via a cluster controller.

When the host sends a screen of data to the 3270, it also addresses the block of data with the line and terminal ID. The communication controller strips off the line ID and sends the data to the appropriate cluster controller. The cluster controller strips off the terminal ID and sends the data to the correct terminal, which displays it on the screen.

EFFECTIVE SNA LAYERS

IBM announced System Network Architecture in 1974. It was, in its first implementations, merely a generalization of earlier terminal-to-mainframe communications protocols. Today, many organizations still use SNA in a strictly centralized way, as a means of connecting terminals to one or more mainframes.

SNA considers a physical network of nodes connected by data lines to be a collection of *logical units* (LUs) linked by *sessions*. LUs can be terminals, printers, or application programs; sessions are the logical connections between LUs and are quite independent of the physical nature of the connection. This independence is made possi-

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ble by the layers of SNA shown in figure 4 and defined as follows:

Level 1: physical control. This is the physical interface between system components often called data terminal equipment (DTE) and data circuit terminating equipment (DCE). A modem is the most obvious example of a DCE. Level 1 defines the electrical characteristics and signaling necessary to make, maintain, and break the connection between the DCEs and DTEs. SNA uses the CCITT (International Consultive Committee for Telegraph and Telephone) V.24, or RS-232, standard most often in the United States. Other CCITT interfaces, such as V.21 for public packet data networks, also are supported.

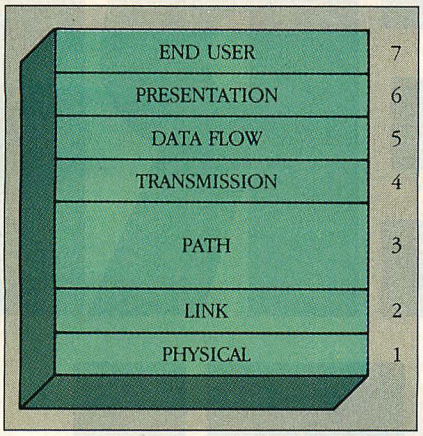
Level 2: link control. Link control provides error-corrected transmission over a single data line between two SNA nodes. SNA uses synchronous data link control (SDLC), a bit-oriented protocol designed to be easy to implement, yet provide a low error rate over noisy circuits. SDLC's line control information always occurs at the same place in a frame, and this information uses a different character set from the text. Thus, a character of text could not accidentally be converted by noise to signal an end of a frame.

Level 3: path control. This provides control from one SNA node to another across the network. Path control routes incoming packets to the appropriate outgoing data link control element (DLCE) or to the correct point within its own SNA node. Path control also creates packets of outgoing messages and disassembles packets of incoming messages. Each SNA node has only one path control function.

Level 4: transmission control. This level establishes, maintains, and terminates logical connections for transfer of data between end users or processes. Transmission control also enciphers data for security purposes, if necessary. Each session has one transmission control element (TCE) per user. Each TCE can be thought of as one end user session's "front office" to the communications network. This distinction between session and user allows a PC connected by an SNA gateway to have multiple sessions, perhaps on different mainframes.

Level 5: data flow control. Data flow control functions to accommodate the idiosyncrasies of message direction and intermittent frequency demanded by the end user. It correlates changes and groups related data into indivisible units. Data flow is concerned with whether the user needs to communicate full- or half-duplex or whether the separate messages are parts of larger units of work as seen by the end user or process. Each session has one data flow control function per user.

FIGURE 4: *SNA Levels*



SNA layers permit connections between LUs to be independent of the physical nature of the connection.

Level 6: presentation services. This level defines the end user's port into the network in terms of code, format, and other attributes. Its job is to accommodate, for example, the totally different interfaces seen by a terminal in one node and what is expected by the application program in another node. Presentation services in SNA performs data compression, additions (such as column headings), and translations (for example, program commands such as **clear screen** into local terminal commands). Customer Information Control System (CICS) and Information Management System/Data Communications (IMS/DC) are two presentation services in the mainframe world (although these products have other functions as well.)

Level 7: the application. This is an SNA end user, a person (or process) that wants to use the SNA network. The end user may be external or internal to an SNA node. External end users may be PCs on an SNA gateway that are accessing a mainframe as a terminal or the mainframe application program in use; internal end users may be application programs resident in an SNA node that will transmit a PC user's file while the PC performs other functions.

SNA layers are more than just taxonomy. They define peer interaction. For example, the transmission control layer need be concerned only about dealing with its peer, the transmission layer, at the other node, and with interacting with the layer immediately above it in its node. It assumes that layers below it do their jobs to specification. Path control can assume that link control presents data to it correctly and need not be concerned about the algorithm used to transmit it without error.

Levels 1 through 3 often are called the transport layers because they are the most concerned with providing transmission services akin to a communications common carrier, such as a telephone operating company.

A node on an SNA network has at least one LU and one PU, *physical unit*, which controls the resources of the node and responds to SNA commands primarily from path and transmission control. It also responds to commands transmitted through the SNA network from the system services control point (SSCP). Each SNA network has at least one SSCP, usually logically in the mainframe host. The SSCP allows end users to access the network, and activates links and LU-to-LU sessions. In a LAN gateway configuration, the communications server acts as the PU.

LOGICAL UNITS

An LU is a device or process at the application level. It may be a terminal, a PC emulating a terminal, or an application program running in a mainframe or a distributed processor such as an IBM 5520 or 3600 financial system controller. Data travel in *packets* along sessions from an LU to the destination LU.

A collection of LUs that share a common path control structure is called an SNA *node* (not to be confused with nodes on a LAN, referred to here as workstations.) Nodes can be connected by multiple links on the low end of the layers and contain a variable number of LUs on the high end.

Each logical unit performs two basic tasks: it activates a session and it uses the session to communicate. The protocol that is used to perform these duties is called its LU session type (or LU type), and it falls under one of three categories:

- LU 0: not specified by SNA. LU 0 is defined by a particular application, for example, the Job Entry Subsystem (JES) of the Multiple Virtual Storage (MVS) operating system.
- Terminals: LU 1 (non-327x printers and other keyboard printers); LU 2 (327x display terminals); LU 3 (328x printers); LU 4 (like LU 1); LU 7 (5250 display terminals).
- LU 6: program to program; release 2 of LU 6 is called Advanced Program-to-Program Communications (APPC).

Gateways that connect PCs to today's SNA networks allow the PCs to emulate LU 2; some allow PC printers

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to behave like LU 3. The higher-level LU 6 protocol allows PC application programs to communicate with other applications either in PCs or in mainframes via a standard program-to-program protocol that does not force the communication into terminal emulation screen images. A typical application is document distribution. Documents are prepared using the document content architecture (DCA) and addressed using the document interchange architecture (DIA). This package, consisting of the DCA document surrounded by DIA address, is sent to a workstation on another network, or to a host mainframe, using the LU 6 protocol.

LAN gateways have the hardware/software potential to support higher-level protocols, although none does at this time. (For a discussion of System Network Architecture, see "SNA Strategies," Art Krumrey, July 1985, p. 40.)

THE LAN GATEWAY

The LAN provides an excellent foundation for developing 3270 emulation to the host. Its wiring provides the infrastructure for node-to-node communications necessary to duplicate the terminal-to-controller cabling of the 3270/74. Shared printers on the network can be used to emulate 3287s, 3289s, or non-327x printers. Shared files on the network hard disk can be transferred to and from the host. A PC monochrome display can emulate a standard 3178 or 3278 (IBM's monochrome terminals), while a color monitor can act as a 3279 (IBM's color terminal).

A 3270 gateway can be implemented on a LAN in two ways. In both schemes, a PC node on the network serves as a gateway to the mainframe. One method has the gateway PC, with an SDLC board, emulating a 3274 cluster controller and connecting to the communications controller via communications lines (figure 2). This PC provides SNA level 1 physical control via modem, level 2 link control via SDLC board, and level 3 path, level 4 transmission, and level 5 data flow control via gateway software. Level 7 application control is handled by the network software (NETBIOS or IPX—inter-packet exchange) and the emulation software in both the gateway and workstation PC emulating the 327x or 328x device.

An alternative method, available only from IBM and CXI, uses a PC with a 3278/79 adapter (see "Emulating the 3278", Roger Addelson, February 1986, p. 48) as the gateway (figure 3). Instead of emulating a 3274, the gateway PC is connected to a port on the 3274 that has been configured as a five-session DFT port. The gateway then divides the five mainframe sessions among the PCs on the network. Here, the cluster controller, not the gateway PC, provides SNA levels 1 through 5 support. The network software, gateway PC, and workstation PC also provide the level 7 support in this configuration.

With the SDLC gateway, the systems can allow as many as 32 host sessions (emulating both terminals and printers). The 3270 coaxially connected gateways permit only five host sessions each. However, this 3270 coaxial connection option offers the advantages of speed—it permits communications with the host at the speed of the 3274—and a lower cost. A 3274 can operate at a maximum 56 Kbaud (remotely using a T1 carrier) and at channel speeds when connected locally to the host. The SDLC option, working only remotely, can operate at no more than 19.2 Kbaud on most gateway packages. Coaxially connected gateways may provide a cost-effective configuration if an existing cluster controller has one free port.

With either scheme, the gateway can operate in dedicated or nondedicated mode. In dedicated mode, the gateway PC acts only as a gateway; in nondedicated mode, it functions additionally as a network workstation (that can be configured as a mainframe terminal). Another use for a nondedicated gateway is to configure the workstation function of the PC as a 328x system printer. Most companies issue a caveat about gateways configured in a nondedicated mode: as the number of sessions increases, users may discover an increase in response time.

LAN gateways have the hardware/software potential to support higher-level protocols, although none does at the present time.

Each workstation on the network can emulate an LU 2 3278/79 terminal and/or an LU 3 328x printer and communicate to the host via the gateway PC. Certain gateway packages enable one workstation to emulate multiple sessions, with a mix of terminals and printers. Some emulation software can be made resident in memory, thus permitting the user to press a hot-key combination to move between the mainframe session and DOS.

File transfer is an important feature offered in most gateway packages. It allows the user to transfer files that are resident either locally or on the network, to and from the mainframe host. IBM has developed a file-transfer protocol (IND$FILE), present in its 3270-PC and in the emulation software for its 3278/79 board, which has become an industry standard. Many 3278/79 board vendors have adopted this standard; however only two vendors other than IBM—Pathway Design and CXI—have accepted this same standard for LAN gateways (CXI provides its own proprietary file-transfer package).

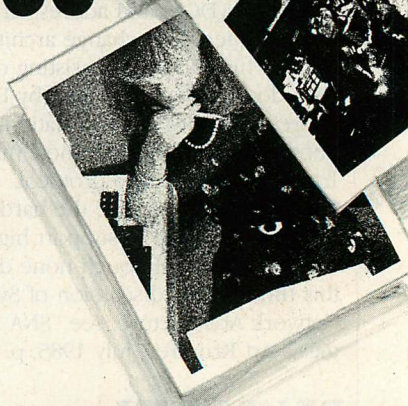
The workstations and gateway communicate in one of two ways. One method, developed when network technology was simpler, uses the network messaging facility to transmit packets between the gateway node and the workstation node. This technique uses the network file server disk as an intermediate point between the nodes and can slow response time considerably. Adding memory to the server and configuring it for large cache buffers will speed up the process.

The other method is node-to-node or peer-to-peer communication, in which the gateway and workstation nodes communicate directly (with no intermediary). Packages that use NETBIOS or IPX protocol take advantage of this technique. They require that the gateway nodes be named (multiple names are allowed for multiple gateways). When the workstation emulation session is initiated, the user enters the gateway node name, and communications with the gateway is established.

Other important features include the ability to configure an emulation session to the appropriate LU 2 327x and LU 3 328x device. Some packages permit reconfiguration of screen colors. This is particularly significant if a composite monitor is being run on an IBM Color Graphics Adapter. Other software options allow configuration of specific versions of the 3278/79 terminal: model 2 (24 lines by 80 columns), model 3 (32 by 80), model 4 (43 by 80), and model 5 (27 by 132).

IBM also offers a variety of specialized keyboards for its 3278/79 terminals. Most gateways allow remapping of the PC keyboard to 3278/79 specification, and many vendors include predefined international keyboards.

Another area in workstation organization is printer configuration. Gateway



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packages usually support both 3287/89 and non-327x printers. In some cases, the software allows the printer tables to be edited so that various makes of PC printers may be attached locally and act as either 327x system printers or screen printers. Other gateway printing features include definition of screen printers for each workstation, and redirection of printer output to disk files.

When configuring the gateway PC as a 3274 (the PU), the user must specify a series of host system and communications parameters (listed in table 1). Packages that run under NETBIOS also require naming the gateway and determining NETBIOS session and command resources. The mainframe systems programming group should provide the host parameters. The final part of the PU configuration is to assign the actual terminal and printer emulation sessions to the emulating 3274's LUs. Sometimes the software allows the LUs to remain in a pool. The LUs are dynamically allocated as workstations establish emulation sessions. Other software is static, requiring assignment of specific LUs to specific workstations or users (some with passwords or IDs). The best gateway software permits both static and dynamic allocation. This may be important to mainframe security software that allows specific LUs access only to specific software. In this case specific network users must be assigned specific LUs.

The second part of the software configuration process includes the definition of LUs and workstation sessions. This involves assigning specific emulation parameters (terminal or printer type, color, and so on) to the specific LUs, and for static allocation, assigning the LUs to the workstations. During this phase, the user's software (workstation) is configured to allow access to the appropriate LUs or pool of LUs.

The gateway packages were evaluated on a network using Novell's Advanced NetWare 286 2.0a LAN software (with Novell's NETBIOS 2.0a emulator) running on Gateway G-Net LNIM boards. A PC/AT with 2MB of RAM and 85MB of hard-disk storage functioned as the file server, and a 512KB dual-floppy-disk PC served as the gateway. The gateway PC was connected to the host IBM 3081D via a T1 carrier subchannel running at 9600 baud (for SDLC connections) or through a 3274C cluster controller and a T1 carrier running at 56 Kbaud (for 3278/79 connected adapters). The products' features are compared in table 2, their technical specifications in table 3, and their overall performance in table 4.

TABLE 1: *Physical Unit Parameters and Glossary*

PARAMETER	EXPLANATION
Station address	This is the destination address that the host computer uses when sending messages to a 3274. This also allows multidrops.
Station block and ID	This identifies the physical unit to the host computer. It acts like a password for dialing the host on switched lines. Ignore this if a nonswitched line is being used.
SDLC window size	This indicates the number of SDLC frames that can be sent to the host at one time. The host communication typically operates faster with a large window size.
Transmission coding	The host transmits data using NRZ (non-return-to-zero) or NRZI (non-return-to-zero-inverted). NRZI is a method for synchronizing the data transmission from sender to receiver. The setting must match the host's.
Line mode	This specifies whether the host and modems can use a constant RTS (request-to-send) signal, or only transmit alternate CTS/RTS (clear-to-send/request-to-send) signals, pause for turnaround, then flow in the other direction. Switched and multidrop lines require line turnaround.
Line type	This specifies whether the line is switched or nonswitched. A switched line requires dialing to the host to make a connection. A nonswitched, or leased, line is always connected.
Line speed	The line speed specifies the rates in bits/second at which information is transmitted. It must match the host's speed setting.

All of the above parameters must be specified when configuring the LAN PC gateway to communicate with the host mainframe's communications controller.

PCOX/GATEWAY

This LAN gateway from CXI, Inc. is designed to allow workstations to emulate the 3270-PC, as is the case with the company's other SNA communications products, and it does a good job. For users who need multiple mainframe sessions with windows, and a notepad or two, this is the product.

PCOX/GATEWAY is the only NETBIOS product tested that functioned under NetWare 2.0a. The extra layer of NETBIOS emulation did not seem to impact performance. Its average time to fill the screen after pressing Enter was 3.5 seconds. (In the same environment, it takes a 3278 2 seconds to fill the screen.) However, some PCOX features did not work. For example, its file-transfer and screen-profile save and retrieve functions use NETBIOS interrupt 7AH. This interrupt is not supported by the Novell's NETBIOS emulator because it is used by NetWare's IPX inter-workstation communications. CXI has indicated that it is working to resolve this interrupt conflict with Novell, but that would seem difficult unless IPX and NETBIOS themselves are made compatible. CXI also has stated that these features do work under Novell's older version Advanced NetWare (1.02) and on other NETBIOS networks such as the IBM Token-Ring Network.

The CXI gateway comes in two versions. One includes a short slot "dumb" SDLC card for direct communications to a 37x5 communications controller. The other has a PCOX 3278/79 Emulator Card for coaxial connection to a 3274 cluster controller. The SDLC card version permits 16 sessions, while the 3278/79 adapter version, acting with a port defined as DFT, can manage 5.

The simple installation involves inserting the short SDLC card in any open slot (except slot 8 of a PC/XT) and attaching a DB25 cable to the modem (or for the short 3278/79 card, an RG62U coaxial cable to the cluster controller). Jumpers on the SDLC card allow default settings to be changed: the interrupt level from 3 to 2 and the base I/O address from 380H to 310H. CXI provides a ROM chip that permits owners of DCA IRMA boards to use them in place of the PCOX 3278/79 emulator for DFT-based gateways.

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The CXINSFIG utility is used to configure the gateway software—the hardware settings, communications parameters, LU and PU definitions, and workstation pools. Of the packages tested, CXI is the only manufacturer that permits a subset of the available LUs to be defined as a pool.

One configuration program screen contains a field for defining the number of NETBIOS NCBs (network control blocks) available to the gateway, an important feature for running under NETBIOS. IBM's NETBIOS and earlier versions of Novell's NETBIOS emulator provided 32 NCBs for application programs; the NETBIOS emulator 2.0a has significantly fewer available. With the number of NCBs set to 20 in the configuration, the gateway aborted with a message indicating that too few NCBs were available from NETBIOS. CXI advised setting the number of NCBs to fewer than 12. The gateway then worked satisfactorily, but a serious performance penalty is paid with just a moderate number of workstations.

The workstation software is configured for each user with the CXICFIG utility, which defines the gateway to be accessed (where multiple gateways are defined), the appropriate LU pool or specific LU number, and the terminal model number for each mainframe session. CXICFIG also defines the API (application program interface) number, international keyboard definition, and printer set-up string, as well as the number of notepad sessions.

The PCOX/GATEWAY emulation of the 3270-PC is very good. With the KeyTronic 122-key KB 3270-PC keyboard, the PCOX emulation comes close to the real thing. This keyboard is optional, however—all functions are available with the standard PC keyboard.

Five host sessions, two notepad sessions, and one PC session are allowed. Multiple windows are set up using the same keys as the 3270-PC: screens can have from one to eight windows, each of which can have a unique size, shape, aspect ratio, position, and foreground/background color. These *screen profiles* can be saved and restored (they were not tested because of conflicts with the Novell NETBIOS), along with the contents of the notepads and the autokey sequence of strokes used in keystroke record, listen, play, and delete functions. The ChgSc key takes the user through the maximum nine active screen profiles.

Within each screen, the Jump key steps the user through windows. If the screen has more than one visible window, the currently active one is delimited by two lines. The Enlarge key enlarges that window to full screen size. This full screen is usually the entire contents of the actual host screen, but CXI also emulates screen sizes larger than 24 lines by 80 columns, such as those offered by 3278 models 3, 4, and 5 and 3279 model 3. For these special sizes, the PC's full screen is actually a window to the larger virtual screen. CXI calls this view of larger screens *presentation spaces* and allows the window to be moved. The contents can be examined by pressing Browse. The Copy key copies part or all of a window from any presentation space to any other space except that of the PC, a restriction also imposed by the 3270-PC.

PCOX/GATEWAY emulates 3270 screen orders correctly. The default keyboard mapping may seem foreign to 3278 users because it is oriented to the 3270-PC, but it can be customized by specifying the scan codes to a utility designed to install alternative keyboards. The system manager can create a .BAT file that begins emulation and immediately restores a screen profile to provide a custom work environment, but an understanding of the specialized functions of the 3270-PC keyboard is required. Screen colors can be designated and the status line uses graphics to resemble the actual line as much as possible. The status line shows the host session number, indicating which of the host sessions available to that workstation user is currently active. The LU number itself is not shown; it is know only to the system manager.

When the KeyTronic KB keyboard is used with the PCOX/GATEWAY package, its emulation of the 3270-PC comes close to the real one.

A printer local to the PC can be used to print host, notepad, and DOS presentation spaces, providing the equivalent of screen printing by other emulators. However, host printer emulation is unique. To initiate host or system printing, the user presses the PrCtrl key, which presents a mock-up of the control panel of an IBM 3287 printer. Some printer keys, such as Enable Print, are controlled by keyboard equivalents designated on the screen. Pressing the Enable Print equivalent causes the Ready light to go on; Hold Print extinguishes it. To receive a system print, one of the sessions must be defined as a printer session by the system manager. The printer session number is verified on this host print screen. The user also must indicate which local printer is to act as the host printer, choosing from LPT1 to LPT3 and COM1 or COM2. Then system printing proceeds to the designated local printer.

The printer must be physically connected to the user's workstation; no redirection to files or network printers is supported. In fact, no facility is included to perform either screen or host printing on a network printer. If periodic system printing is a requirement and the PC serving as a gateway is not needed for display emulation, a good strategy is to keep a host print session active on the gateway PC, with a printer physically connected to it. This printer would be accessible to network users by its host address; it would not be available for local functions.

LU numbers can be assigned explicitly or pooled. Unlike gateways that offer end users a choice, CXI lets the manager reserve assigned LUs so that they are not available to users who are assigned LU numbers from the pool. In addition, users are not able to change their LU assignments. The CXI method of assigning LUs is the most versatile and the most secure.

The function and versatility of PCOX/GATEWAY, however, comes at a great price: memory. After accounting for DOS, the NetWare shell, the NETBIOS emulator, and the CXI product, only 130KB was left for DOS applications in the test configuration. Because the memory overhead of the NETBIOS emulator is 18KB, the product itself runs about 320KB, and limiting the number of screens does not lower memory requirements significantly. As a result, no significant PC applications were tested. Conventional memory requirements for PCOX/GATEWAY can be reduced by installing a CXI Memory Plus board to provide 128KB of memory (separate from the 640KB available on the PC) for the emulator's use.

CXI offers three file-transfer options: IBM-style SEND/RECEIVE commands that cooperate with IND$FILE on the host, and thus require that product; basic file transfer that works only with text files, and uses the ISPF editor on the host; and advanced file transfer that works with binary and text files and uses data compression and blocking to

speed the transfer. This last option requires installing a special CXI program on the host. The second two options are packaged separately as PCOX/FILE TRANSFER; however, no file transfer products could be tested because of the NetWare interrupt conflict. Finally, PCOX provides an API that is compatible with the 3270-PC API.

NAS SINGLE BOARD SOLUTION

National Advanced Systems' Single Board Solution (SBS) is distributed by at least two vendors: Novell and Quadram. The communications server contains the board's SNA intelligence. The board keeps the SDLC link with the mainframe host active even if the communications server PC is rebooted. Obviously, NAS implemented the SNA link protocol layer in the board to achieve this continuity and efficiency.

This specialized board design impacts the product's performance in two ways. First, its mainframe response time is the best of the systems tested, shaving a second off the approximately four seconds logged by the other products. Second, the implementation of the link layer in the board keeps host sessions active even if the network or communications server has to be restarted. This saves the trouble of having host personnel restart the SDLC/SNA line. It also increases exposure to the security risk of another user being connected to a mainframe session in progress if the first user leaves the workstation. (However, most mainframe software breaks from a session after a period of inactivity or when a password requires revalidation.) On the other hand, the SBS gateway system, with the special board, is more expensive than the CXI or Pathway Designs packages.

Because the board handles most of the gateway functions, the PC in which it resides is free to act as a mainframe workstation (nondedicated gateway) with no distinguishable decrease in performance. Under SBS, a printer session must be active to accomplish mainframe system printing. The gateway server, running in nondedicated mode, is a good candidate to run this session. A user workstation cannot run a printer session and a 327x session together.

SBS 4.5 is much improved over earlier versions: it supports multiple sessions, optional menu access to programs, an API, and file transfer. Installation is easy, menu-driven, and streamlined (the installation section of the manual has been reduced from 25 pages to 4). The board comes configured with a default setting IRQ 3 and a base I/O address of 380H. Changing these to alternative settings of IRQ 2 and 300H is a matter of moving some of the jumpers. SBS may be installed in any full-length slot in the PC.

Software installation also is easier. NAS has redone the cumbersome process necessary in earlier versions. SBS 4.5 installation is completely automated, not with .BAT files, but with .EXE files that actually create the subdirectories, copy all necessary files, and modify the programs to reflect the hardware settings. The installation software displays Novell-like menus (with windows). Once the software is installed, the SBS main menu enables the user to call supervisor functions, including PU and LU configuration, terminal and printer customization, and gateway initiation.

The SBS system also emulates 3270 screen orders correctly. Its default keyboard mapping differs from an IBM 3278 in some commonly used keys. Emulation sessions are defined by display configuration files (DCFs) that allow the system manager to specify the LU number, case mode, 3279 color mode (2 or 4 only), and the hot-key interrupt. The DCF specifies whether the numeric lock and audible alarm features are to be enabled, the path name for local copy, and a terminal definition file (TDF) that allows alternative emulation key assignments. This display emulation does have two shortcomings: first, the IBM Enhanced Graphics Adapter is not supported; second, composite displays connected to color/graphics adapters display unprotected fields normally viewed as green on a 32-by-90 screen in a barely visible shade. This was the only gateway tested that does not allow the system manager to change color assignments, which could bypass the problem. The status line contains mostly text rather than the familiar 3278 graphics, but the test is easy to interpret.

Emulation is initiated either through a master menu or by commands inserted into a .BAT file. The first-time user can begin a session by

TABLE 2: *Package Features*

	CXI	NOVELL/ QUADRAM	PATHWAY DESIGN	IBM
Product	PCOX/ GATEWAY	NAS Single Board Solution	netPATH SNA-3270	3270 Emulation
Multiple gateways on network	●[a]	●	●	●
Multiple host sessions from one workstation	●	●	●	○[b]
Emulation of 3270 printers				
Local	●	●	●	●
System	●[c]	●	●[c]	●
Redefinition of keyboards	○	●	●	●
International keyboards	●	●	●	●
On-line help facility	○	○	●	○
Redirection of printer output and screen image to file	○	●	●	●
Application program interface	●	●	○	●
File-transfer package	●	●	●	●
IBM (IND$FILE) protocol	●[d]	●[e]	●	●
Concurrent with DOS	●	●[f]	●	●[g]
Hot-key between sessions	●[b]	●[f]	●	●
Reconfigure screen colors	●	●[i]	●	○
Menu-driven	○	●	○	●
Command-driven	●	●	●	○
Models of 3278/79 emulated	2,3,4,5	2	2	2

● = *Yes* ○ = *No*

[a] *Up to four*
[b] *One display and one print only*
[c] *Cannot be used with network printer*
[d] *Also bundled with CXI proprietary file-transfer software*
[e] *Not included in package, available from CDI, Inc.*
[f] *Only in single-session mode*
[g] *If alternate task defined during installation*
[h] *3270-PC-type windowing (also notepad sessions)*
[i] *Only two- or four-color*

Each one of the four products reviewed offers some form of file transfer in addition to 3270 terminal emulation.

TABLE 3: *Technical Specifications*

	CXI	NOVELL/ QUADRAM	PATHWAY DESIGN	IBM
Product	PCOX/ Gateway	NAS Single Board Solution	netPATH SNA-3270	3270 Emulation
Attach to host via SDLC	●	●	●	●
Attach to 3274 via coaxial	●	○	○	●
Reconfigure interrupt level and I/O address	●	●	●	○
Dedicated gateway	●	●	●	●
Nondedicated gateway	●	●	●	●[a]
Protocol				
Novell (IPX)	○	●	●	○
NETBIOS	●	○	●	●
Number of sessions				
SDLC	16	32	32	32
Coaxial	5	N/A	N/A	5
Maximum communications rate (kilobaud)	19.2	19.2	19.2	9.6
Default interrupt level	3	3	3	3,4
Default I/O address	380	310	380	380

[a] *When configured as a gateway and network station during installation*

Each one of the four systems reviewed permits the gateway PC to be used as a workstation if the user so designates.

picking a few menu options. Even an experienced user might use the menus to obtain access to various systems or to select different configurations of devices. The routine user probably would put the start-up commands into a .BAT file. Either a menu option or the DCF file contains the LU number to be used for a session. After selecting the option that connects the workstation to the gateway server, the user chooses one of three emulation modes: single-session, multiple-session, or printer.

Only single-session emulation permits switching to DOS via hot-key (Ctrl-Z). This is a peculiar selection for a hot-key because Ctrl-Z signifies end-of-file for a file input from the console. The hot-key specification can be changed in the DCF, as noted above. In multiple sessions, Ctrl-Z is used to suspend activity with a particular session. A command such as DE MY.DCF is needed to jump to another session or back to the original session after DOS activity. (The menus can be used to switch sessions, but this can be tedious if much switching is needed.) In this area, the other packages have the edge.

Full printer emulation, both local and system, is supported and is well integrated into the network. The DCF file specifies a local print path name, which can be a file or device name. A device name can be a name that has been redirected to a network printer. If the redirection is done with the new "time-out" parameter of Advanced NetWare 2.0a, the screens will print automatically after the time-out period elapses. The Alt-I combination can be used to change the print path name to a file or to another device name. LU numbers are not needed to name local printers. System printer emulation must be accomplished by explicitly selecting it after terminating or suspending other sessions—no display emulation is possible during.this time. System printer data also can be directed to network printers or files. If the PC serving as the gateway or communications server is not necessary for display emulation or PC activity, it could be designated to handle system printing (if continual system print capability is necessary).

The assignment of LU addresses is a concern where host installations use the terminal address to determine security privileges. With SBS, LU numbers can be explicitly assigned or pooled. If pooled LUs are used, no method is available to ensure that unused LUs with host-specified privileges are not assigned to a session that simply takes the next one in the pool. For example, a problem occurs if user 1, who normally is assigned a particular LU that has host-specified privileges, is not using that LU when user 2, whose LU addresses are unspecified, loads the emulator. User 2 may get user 1's address LU, which keeps user 1 from accessing that LU and exposes the data to which only user 1 is supposed to have access. LUs are specified in the DCF, the editing of which requires a password, but the menu-oriented session start-up procedure lets the user specify the LU number. The only way to restrict exposure to privileged LUs is to not give all users the menu-oriented SBS command, but rather require access through commands or .BAT files that specify the proper DCF configuration file.

When the hot-key facility of single-session emulation was used, no problems were encountered in the DOS session. The single-session emulator used less than 100KB of memory, so most applications could be run. SSI's WordPerfect 4.1, Lotus' Symphony 1.1, and Borland's SideKick all worked well.

Release 4.5 also supports an API, which allows a DOS program, calling API routines, to interface with the 3270 session. The NAS API is compatible with the IBM 3270-PC API.

The SBS package provides a file-transfer program called XFER that interacts with the TSO line editor. It worked very slowly, and could not manage fully qualified TSO file names; however, it did not require any special cooperating host program. Transferring binary files went even slower because they are encrypted into an expanded form that is suitable only for uploading to a host and downloading to a PC.

(A file-transfer package for SBS 4.5 that uses the familiar IND$FILE SEND/RECEIVE transfer protocol with API calls is available. CDI, a name familiar to some PC 3278/79 emulation users, has developed IND$FILE-based file-transfer packages for most popular 3278/79 emulators and 3270 LAN gateways on the market. Several vendors bundle CDI programs with their products. A single-user version of the file-transfer package sells for $129; license prices for the NAS LAN gateway have not been determined.)

netPATH SNA-3270

This SNA gateway from Pathway Design was one of the first packages to run in the Novell NetWare environment. NetPATH is a full-function gateway that operates directly under NetWare: NETBIOS is not required.

NetPATH installs easily and its documentation is well presented. Its proprietary communications adapter allows multiple communications boards to be installed in one communications server

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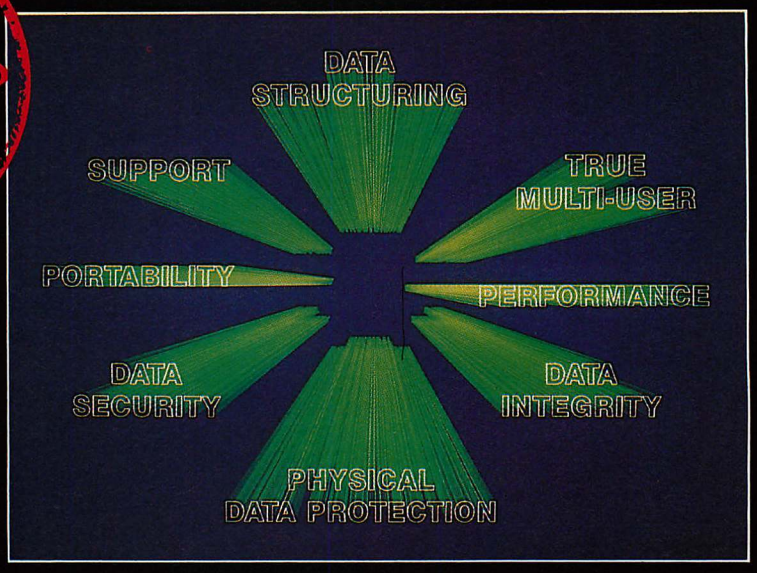

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by permitting the installer to change I/O address and interrupt levels (the defaults are IRQ 3 and I/O 380H). The intelligent SDLC adapter has an on-board CPU and memory, and handles communications with the host independent of the gateway PC. It connects to a 37x5 RS-232 port and can coexist with 3274s on a multidropped line; it cannot connect coaxially to an existing 3274, nor can it connect to the IBM host via token-ring. The software interrupt levels of the emulator running in the user's workstation also can be changed if it conflicts with other programs.

The software is configured using the BLDPU (build physical unit) and BLDLU (build logical unit) utilities; both are menu-driven. BLDPU requires entry of the host system and communications parameters listed in table 1, as well as the LU type (2 for terminal or 3 for printer) for each of the 8, 16, or 32 LUs allowed. BLDLU defines the LUs for each workstation (pooled or dynamically allocated), as well as terminal or printer model, print redirection, and color definition. All that remains is to create .BAT files with which each user will initiate emulation, access the network subdirectory where the gateway emulation programs reside, and, finally, start up the gateway.

All 3270 screen orders are emulated correctly by netPATH. Its default keyboard mapping differs from an IBM 3278 in some commonly used keys, such as Clear, Erase Input, and PA1, although it is arguable that Pathway's mapping makes more sense. Key assignments can be changed for each LU, so the installer could make them match IBM's more closely, if desired. The package comes with a set of international keyboard definitions. Screen colors can be selected for each LU, and the screen status line can be configured to use words or graphics. The graphics status line makes effective use of PC graphics, providing the user a concise presentation of LU status that will be very familiar to the 3278/79 user. The installer also can choose an alphabetic status line with words such as "ready," which may be more helpful than graphics to the less experienced 3270 user.

Each workstation can have as many as five LUs assigned, consisting of displays and printers. Pressing Alt-F10 permits stepping through the display LU type 2 addresses. The screen printer can be selected with the familiar Ident key if the user is allowed multiple printers. Full printer control, including redirection of the printer to a disk file, can be achieved using the emulation control key, F10, followed by the F3 menu choice for printer control. Each printer is assigned an LU type 3 address that makes it host-addressable if the host is aware of it; a range of LU addresses outside of the host's range can be used for local screen printing only. NetPATH's major restriction in this area is that print cannot be directed to NetWare printers, even if a workstation's LPT1 is redirected to a NetWare printer. Both screen and system prints can go only to a local printer or file.

A unique feature of netPATH is its on-line help screen. Again, pressing F10 brings up a menu with selections for printer control, ending emulation (with the associated release of the resident portion memory), or on-line help. The help function displays the keyboard layout and mappings.

NetPATH allows the installer to assign specific LUs to specific NetWare users and also to set up a pool of LU addresses; however, as with NAS, specifically assigned LUs remain in the pool of available LUs. The network installer must either fully specify LU addresses or fully pool them to prevent unauthorized access to reserved LUs. The more efficient pooling method is an option only if host security is not specified by LU address. The ideal arrangement would be the ability to specify LUs for the frequent or privileged user and pool LUs for all others.

NetPATH (with ftPATH) is a mature product that requires only minor improvements to provide a full range of options, and it is cost effective.

In a test host environment with 3278s connected to a 3274 that communicates with the host at 9600 baud, a 3278 begins to fill the screen in less than a second from the time Enter is pressed, with another second needed to fill the screen. With the netPATH communications server also connected at 9600 baud, netPATH begins to respond in just over 3 seconds; another second is needed to fill the screen (see table 4). The cause of this delay is that server-to-workstation communications take place through shared files on the file server, rather than through Novell's IPX peer-to-peer protocol. This is not as bad as it could be because NetWare caches disk file data in the file server's memory, which can be 80286 extended memory if such a machine is used as a file server with 286 NetWare. Still, the response time will be a disappointment to a former 3278 user or even to a user with a 3278/79 emulation adapter. Pathway has stated that it intends to use the IPX protocol in future releases.

NetPATH does allow hot-key jumping from host terminal emulation to PC session. However, the product uses 148KB while resident, thereby reducing the amount of memory available to PC applications. This amount is already reduced by the 144KB overhead of DOS 3.1, the NetWare shell, and, in the test environment, a small resident utility called Pro-Spool that allows spooled print files to be released. WordPerfect 4.1 and Lotus Symphony 1.1 intermittently locked up when netPATH was resident. Because of this, emulation was suspended during testing when it was time to begin a large PC application.

Suspending emulation does not terminate the host session, but pooled LU assignment could allow another user starting netPATH to be assigned the suspended session. The PC session does not continue to run concurrently when the user presses the hot-key to move into the 3270 session. PCOX/GATEWAY and netPath are the only products that permit hot keys and file transfer from multiple host sessions (although PCOX file transfer did not work on the test system because of the aforementioned interrupt conflicts with NetWare).

Pathway Design's package includes a product for file transfers called ftPATH, which offers full equivalents of the SEND/RECEIVE commands of the 3270-PC and IBM's 3270 Emulation Program. Its commands cooperate with IND$FILE, and permit a variety of record formats and file types. The ftPATH SEND and RECEIVE operations performed flawlessly at speeds comparable to a coaxially connected PC, particulary for files larger than 8KB. No PC or host activity with another session is possible while ftPATH is transferring files. No application program interface or higher-level protocol such as LU 6.2 can be used with ftPATH or netPATH. At the time of this review, netPath was the only package available to come standard with an IND$FILE-based transfer package that functions with Novell's Advanced NetWare 2.0a.

NetPATH (with ftPATH) is a mature product that requires only minor improvements to provide a full range of options, and it is cost effective. Its major

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TABLE 4: *LAN Gateway Ratings*

	CXI	NOVELL/ QUADRAM	PATHWAY DESIGN	IBM
Product	PCOX/ GATEWAY	NAS Single Solution Board	netPATH SNA-3270	3270 Emulation
Time from pressing Enter to fill screen (seconds)[a]	3.5	3.0	4.0	4.0
3270 control: screen	Excellent	Fair[b]	Excellent	Good
3270 control: printer	Excellent[c,d]	Excellent[e]	Excellent[d]	Good
Ease of use	Good	Excellent	Excellent	Fair
Ease of installation	Good	Excellent	Good	Poor
Quality of documentation	Excellent	Good	Good	Fair

[a] *A 3278 takes two seconds to fill screen*
[b] *Color mapping poor*
[c] *No redirection of print to a file*
[d] *Does not use network printing facilities*
[e] *Uses full Novell network features*

Each one of the gateway products reviewed offers a good individual performance.

drawbacks are response time, lack of network printer support, and conflicts with concurrently running software.

IBM 3270-PC EMULATION

Although the IBM PC Local Area Network version 1.1 package ran properly under Novell's Advanced NetWare 2.0a NETBIOS 2.0a, the IBM SNA gateway did not. For this review, the gateway was operated on a two-station broadband IBM PC LAN with the version 1.1 software. It is included as a base against which to assess the other products and as IBM's most significant product in 3270 emulation on standard PCs.

IBM's version 2.0 replaces the earlier IBM PC Network SNA 3270 Emulation Program. It is part of a family of programs that includes the IBM 3270-PC Emulation Program, Entry Level; the IBM 3270-PC Emulation Program version 2.0; and the IBM 3270-PC Control Program version 3.0.

Version 2.0 of the program works in the following environments:

- IBM PC compatible (must be a close compatible—it would not run on an AT&T 6300) with IBM 3278/79 Emulation Adapter connected to a host DFT port on a 3274 controller (figure 1).
- IBM PC compatible with SDLC adapter connected to a host 37x5 port and acting as a stand-alone workstation.
- IBM PC compatible on an IBM Series/1 acting as a gateway.
- IBM PC compatible on a NETBIOS network on which a PC (also running version 2.0) serves as a gateway with a DFT port connected to a 3274 controller; the PC gateway also can be used as a host network station. Only five host sessions are supported on this configuration (figure 3).
- IBM PC compatible on a NETBIOS network on which a PC, also running version 2.0 of the program, acts as a gateway with a SDLC adapter connected to a host 37x5 port. The PC gateway also can be used as a host network station (figure 2).

Version 2.0 complements the Entry Level program and provides a similar user interface, thus consolidating the IBM-provided emulation environments. Like the other gateways, hardware installation requires a short SDLC card installed in any open slot (except slot 8 of a PC/XT). The SDLC card is connected to a modem on the host via a DB25 connector cable. The coaxial version requires either the new short 3270 emulator board or an old long 3278/79 emulator board installed in the PC and connected to a 3274 cluster controller via coaxial cable (RG62U).

Software configuration is menu driven; little text entry is required. The gateway configuration process includes communication parameter selection that permits specification of the items in table 1 and identification of the network nodes serving as 3270 workstations.

Workstation configuration includes running the communication profile task for each workstation, which allows the specification of items in table 5. An *alternate task* is the IBM nomenclature for a DOS session task. Foreign language keyboards can be specified by the same three-digit number used in other IBM PC software. The communications set-up selects numeric lock, printer use, file transfer, and API. The gateway set-up selects a gateway name and the number of sessions.

The installation procedures are not well-defined, nor are they well organized in the manual. Various bits of information must be assimilated before a successful installation is achieved.

The configuration tested is described last in the list above; it was run as a two-station network. Host response time was good—generally 3 seconds, and the emulation is clean; however, no multiple mainframe sessions or windows are supported. The 3270 screen commands presented no difficulties.

The IBM keyboard mappings are peculiar. For example, the host program function (PF) keys are emulated by holding down F4 and pressing keys 1 through = on the top row for PF1 to PF12, and second-row keys Q through] for PF13 to PF24. All other emulators used the Alt key with the top two rows—which is consistent with an actual 3278. The 3270 Enter key is simulated by the PC's End key; all other emulators use the PC's Enter key and a different key for NL (new line). This may be justified because some applications require more NLs than 3270 Enter keystrokes. The new IBM enhanced keyboard is supported and yields very usable mappings. In any case, keyboard mappings may be customized.

The status line includes important information in a mixture of graphics and text, including helpful comments such as "Wait or dev cancel" as action options. Screen colors cannot be changed, which creates a problem for composite displays with green fields that represent colors as shades of gray.

The emulation software always begins with a menu that gives three options: communicate, communications profile tasks, or exit. The menu cannot be bypassed to go directly to the communicate option. Communications profile tasks allow the specification of items in table 5, as discussed above.

The IBM printer support is complete. The profile tasks option selects the user PC printer as a local printer, a system printer, or both. Print can be redirected to a file, but some conditions —such as a full diskette—can hang up the mainframe print manager with no message sent to the workstation.

This system does include a special facility for capturing screen images to a file. (Although the file name suffix of .PRN is unusable and locks the workstation if specified—and this is not documented.) Print also can be redirected to a network printer through the NETBIOS interface in the same way that any print data to LPT1 are redirected. Printer width and page size controls are available. A print session and a display session may be assigned to a workstation

that allows system printing to proceed simultaneously with display activity.

All LUs are assigned to workstations on a fixed basis. No pooling of LU numbers is permitted, therefore no risk of security exposure of privileged LUs can take place. The versatility of pooling LUs is lost, but because *each* workstation must have its own copy of the version 2.0 program, careful planning of which users will have host access is required in any case.

The IBM memory requirements are modest. The basic network station consumes 153KB. With file transfer, DIR key support (which displays a DOS directory while in display emulation mode), print support, alternate task support, API support, and other options, the memory consumption increases to 208KB. Thus, many DOS application programs could fit in the remaining memory of a 640KB machine.

File transfer uses the SEND /RECEIVE commands and the host IND$FILE program, offering good transfer speed. File transfer can be started from a menu accessed by the Reqst key. This menu includes useful displays of the status of the configuration; the gateway configuration of the program shows all sessions, the network assignments, and activity status. The API is a subset of the 3270-PC API.

THE RIGHT CONNECTION

Each of the gateway products reviewed stands well on its own. With the exceptions noted, the products perform as promised. Each is well suited to a particular application environment.

CXI's PCOX/GATEWAY is quick and handles multiple mainframe sessions well. It is a good choice for the user who spends time in several mainframe sessions. The CXI 3270-PC windowing feature also recommends it for cut-and-paste of mainframe data into notepads. PCOX uses substantial memory, leaving little room for any significant concurrent DOS applications, and the Memory Plus card adds only 128KB. Most versions of PCOX handle IND$FILE file transfers and API.

NAS SBS 4.5 is best suited to the user who is generally in DOS mode on the Novell network. It uses the least memory for its resident routines. NAS works well overall, but is most powerful in single-session mode supporting API and file transfer (IND$FILE with CDI's package). SBS 4.5 takes full advantage of the Novell network facilities for printer redirection and spooling. It is, however, more expensive than the CXI or Pathway products.

TABLE 5: *IBM 3270-PC Emulation Workstation Options*

ITEM	CHOICES
Configuration	Stand-alone station Network station Gateway Gateway with network Station
Communication attachment	SDLC or DFT
Alternate tasks	Yes or no
3270 keyboard	1 to 999
3270 keyboard remap	Yes or no

Configuration includes specifying the above items for each gateway workstation.

Pathway Design's netPATH spans the middle ground. It handles multiple sessions well, allowing IND$FILE transfers from any mainframe session. It uses a moderate amount of memory, leaving sufficient room for application programs. NetPATH does not support API or network printing. When Pathway solves the problem of netPATH interactions with some DOS applications and adds API, this could become the best package available.

IBM 3270-PC Emulator version 2.0 is a special case. Unlike the other products reviewed, it does not run on the Novell network. Because IBM products traditionally become industry standards, it provides a good base for comparison. The IBM product offers fast emulation, good printer support, easy configuration, and reasonable memory requirements. Drawbacks are its keyboard map, menu-only access, single-host display session support, and price (for large networks). The manual is helpful to the system manager; however, it can be overwhelming to the workstation user—a supplement should be provided. The IBM gateway is, of course, suited to users running the IBM PC Network or IBM Token-Ring Network with NETBIOS. It seems to function only in IBM PCs or close compatibles. IBM could be the least expensive option for small configurations (with fewer than 6 stations), although it quickly becomes the most expensive option for larger configurations (12 or more).

Certainly, this analysis shows that, at least for now, each user situation will suggest which LAN gateway is best for its particular needs. No one product stands out as the best for all circumstances. PC networks and LAN gateways will continue to grow in sophistication and scope. Users will need to stay informed to make the best current hardware/software decisions for individual application arrangements.

PCOX/GATEWAY: 8 LU, $2,595; 16 LU, $4,595; DFT version, $2,995
Memory Plus board: $395
CXI, Inc.
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NAS Single Board Solution: 8 LU, $3,295; 16 LU, $4,995; 32 LU, $5,995
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NAS Single Board Solution: 8 LU, $4,529; 16 LU, $4,983; 32 LU, $5,742
Quadram Corporation
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Pathway Design, Inc.
One Apple Hill
P.O. Box 8179
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617/237-7722
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IBM 3270-PC Emulation Program 2.0: $425 per workstation (including the gateway)
IBM SDLC Adapter: $240
IBM 3278/79 Emulation Adapter: $595; 8 LU, $3,640; 16 LU, $6,640; DFT version, $2,720
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That opens up the widespread culture of dBASE installations to exploitation by C programmers. Tap that market, avoid the resident dBASE language, and gain the advantages of C with this single product.

dBC's functions parallel all dBASE's file handling commands, many decomposed to give closer control. Each backed by demo source files on disk.

Use dBC for custom work for clients, or on its own. It's a complete ISAM file manager for C whether or not dBASE will be used in tandem, supports all four memory models, and can have sixteen index and data files open. Big discount to buyers of both dBASE II and III versions. Specify Lattice, Microsoft 3.x, or DeSmet.

Versions:		List:	PC Brand:
L00II	For dBASE II	$250	$195
LCCII	With Source	$500	$390
L0III	For dBASE III	$250	$195
LCIII	With Source	$500	$390

MICROSOFT C 4.0 *A Great C Battle Rages and You're Winning*

As the dreadnaughts pound each other with ever heavier ordnance, today's programmers reap the spoils of this war. Bundling a source debugger and a "make", and sporting a "huge" memory model permitting single data objects larger than 64k, the Microsoft C compiler has jumped a full version number to 4.0. But what's really impressive are the benchmarks reported in Dr. Dobb's (8/86) encyclopaedic survey of 17 C compilers. Microsoft's and IBM's C (licensed from Microsoft) run away with the contest winning 11 of 27 benchmarks.

The CodeView™ debugger, free for a limited time, uses windows to show everything on one screen: source alongside disassembled object, variables, stack and registers. Drop down windows—use a mouse if you like—obviate learning of commands. "A source-level debugger that puts the rest to shame" (Dobb's),

Microsoft C now has five memory models for code and data, plus non-library support for another thirteen, and boasts alternate math packages for speed versus accuracy, with or without 8087/80287 chips. A big plus in multi-language settings: call from this C any routine written in later versions of M'soft Pascal, FORTRAN, or Macro Assembler. Object code of all four may be intermixed come link time or commingled into libraries.

Both linker and library manager are part of the package, as is the "make", a UNIX™ name for a smart batch program which knows to expend minimum effort to rebuild any size of project by compiling and assembling only elements affected by new or changed modules.

It is reportedly used by Lotus, Ashton-Tate and, fittingly, Microsoft itself to develop Windows. Dobb's calls it "the best MS-DOS C development environment value today [for] virtually any kind of program conceivable." 320k suggested.

Ask for:	List:	PC Brand:
G0500	$450	$295

CURSES *Unix Style Screen Management*

Curses from Lattice™ manages the screen of the PC like Unix™ curses. Library of 84 functions and macros parallels Unix with matching parameter lists. So Unix programs are at home on the PC, and vice versa. Keeps any number of screens in memory, supports color, vast function set to get characters, wrap lines, scroll, blank lines, highlight, etc. Like Unix refreshes screen only on your command. Ask for: L0850. List: $125. Here: $99. With Source: L0860, $250/$199

PANEL *Feature-Laden Screen Design Tool*

Writing your own screenware can blow completion dates and profits. Panel™ works with you interactively to set up foolproof screen displays and data entry forms rapidly. Output is C source code.

Not just single plane: layer your screen designs with up to ten overlapping images: Background pop-up lists, help boxes, and alternate input fields.

Panel builds in a user interface for keystroke movement within and between fields, supplies validation routines for checking user field entries. Diverse attributes may be selected for any field — size, data type, color, conversion of input to upper case; clearance of existing data when new entry is started; masks for standard formats (eg, dates); phrases which fill in when their first letter is typed; multiple-choice lists from which to choose by cursoring a highlighted bar. Fields may be multi-lined and scrolled if larger than the screen space allotted them. Specify: S0400 & Compiler. List: $295, Us: $229

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We refund the purchase price of any product returned within 30 days in entirely resalable condition. **You can even try out programs themselves** if product code begins with E, T, or L through N — even if it means breaking the disk seal. Some developers do pose limits, so for products beginning with other letters, opening sealed disks constitutes acceptance. But you can at least review the manual. There's just nothing stopping your buying from PC Brand.

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GREENLEAF FUNCTIONS *Bountiful Harvest*

C source, assembler source, and binary libraries of 225 functions for many compilers. Emphasizes tight functional groupings to minimize loading code which your application may never use. Manual helps select functions, bulletin board, too.

A sampling: *DOS* extensions for file and directory manipulation; *Screen:* to select mode, page, monochrome or color, palette; cursor shape, positioning; clearing and scrolling; pixel get and put; read light pen. *Strings:* Center, justify, etc.; efficient list operations which add, delete, sort string pointers for top speed. *Other:* graphics character primitives, keyboard status, function key assignment, time/date, read registers and memory size, peek and poke. Mature best-seller. Specify: S0770 & Compiler. List: **$185**, Here: **$139**

PFORCE *Phoenix Pfunction Pfestival*

Lotus® didn't do badly pulling it all together in one place. Phoenix has followed suit with the ultimate integrated C library, offering everything from low level functions for hardware access to complete b-tree database management. Along the way are prerequisites such as string manipulation, time/date, field and screen editing, but also four styles of menus (Lotus included), windowing, background tasking, DOS interfaces, directory management, even interrupt-driven communications. Design emphasizes objects, so characteristics of windows, databases, records and fields can be initiated and changed outside functions.

One large collection in place of bits and pieces means one set of instructions and PforCe™ has tutorials, extensive examples, quick reference, and on-line help.

Everything in source, no royalties, all memory models of Lattice, M'soft. Specify: S0220 & Compiler. List: **$475,** PCB: **$349**

GREENLEAF COMMUNICATIONS *Hello World*

Want your application to communicate with other users or remote date bases by asynchronous communications built right into your C programs! Even if you don't need it now, that's a skill to have at the ready!

120 functions *and demo programs in both C and assembler source code* set up separate transmit and receive ring buffers for up to 16 simultaneous channels. Interrupt driven so you can halt an incoming record, display it, file it, let the user edit it, then continue. Goodbye separate communications software.

Supports up to 9600 baud, ASCII or binary, any parity or word length, 8250 UARTs, Xon/Xoff and Xmodem, WideTrack receive. Specify: S0750 & Compiler. List:**$185**, Us: **$139**

PRE-C *Pick the Lint from Your Program*

Pre-C is like UNIXs lint. It finds problems your compiler won't. Problems that a debugger will have trouble figuring out. Even problems which will cause trouble with other compilers.

Compilers see one module at a time. Modules only meet at link time. Pre-C looks at *all modules at once* and reports conflicts in data type declarations; function call parameters which disagree with functions, machine-dependent expressions which inhibit portability. It spots obsolete usage (even C changes), casts with suspect conversions, variables never used, functions never called, unreachable code. Adheres to UNIX System III compile standard to ensure your portability. Ask for: P0590, List:**$295,** Ours:**$208**

DAN BRICKLIN'S DEMO PROGRAM *Storyboard Your Program*

The Legendary One has created Metaphor Two when the rest of us are still on Zero. Dan's first was the original electronic spreadsheet (VisiCalc™). This one is for programmers.

Words don't express program ideas because programs are screens! Dan's Demo creates slide shows. Create a screen — a snapshot of your planned product as it runs. Anything goes: words, borders, box rules, inverse and underlining of monochrome, fore- and background color. Copy this "slide" to an empty screen. Change it a little, to show the next instant of run-time. Do it again. Presto, a whole slide show of your program in action.

All 250 characters and attributes are available from scrollable lists which pop to the screen. All commands are layered in Lotus-style pop-up menus. Frequent choices mapped to function keys as well. 80x25 character mode, not bit-mapped.

Screen areas can be blocked for cut and paste or filled with color or characters, even blink. Slides can overlay on others, can be shuffled, deleted. Slides can proceed at time intervals or branch anywhere in the slide sequence depending on user keyhits.

Invaluable to prototype the program you are about to write, to position the labels, choose the color decor, smoothe out the keystroke interface. Or load the "capture" utility and snapshot the screens of any running program for an instant slide show.

Each copy entitles you to redistribute fifty of the slide projector program that runs demos. Plain manual, no binder keeps price of big product small. "Might . . . become *the* essential tool in . . . user interface prototyping," *Tech Journal.* Ask for: N0100. List: **$75** US: **$69**

BASTOC OPTIMIZES! *Translates BASIC Into C*

For a trifling price, BASTOC™ moves truckloads of BASIC code over to C. It's a translator which takes in Microsoft Extended BASIC and emits pure K&R C for Lattice 3.0. It will optionally convert your program into a single monolithic C function or decompose it into separate functions, one for each GOSUB label.

Version 2's optimization dramatically reduces execution time. Converts to integers those variables in BASIC programs which do not need floating point. Where BASIC uses full assignment statements to increment counters, BASTOC converts to C's compact form. Strings dynamically allocated ridding your application of BASIC's catatonic halts for garbage collection. Creates structure of even convoluted BASIC code. Huge worksaver.

Ask for:	List:	PC Brand:
S0375	**$495**	**$399**

Shopping List for the Power Workbench

	LIST	OURS
ASSEMBLERS & DEBUGGERS		
Advanced Trace-86 *Morgan, ASM Interpreter*	175	**149**
Codesmith-86 *Debugger by Visual Age*	145	**109**
Cdebugger *by Micro-Software Developers*	165	**139**
CSD Debugger *C source level by Mark Williams*	75	**75**
C-Sprite Debugger *by Lattice, source level*	175	**139**
Microsoft Macro Assembler *with Utilities*	150	**109**
Periscope I Debugger *Data Base Decisions*	295	**269**
Periscope II *Data Base Decisions*	129	**111**
Pfix86 *by Phoenix, Assembly level debugger*	195	**149**
Pfix86 Plus *by Phoenix, Symbolic Debugger*	395	**279**
BASIC LANGUAGE		
BetterBASIC *Summit Software*	195	**165**
BetterBASIC Utilities *8087 Math Support*	99	**85**
Btrieve Interface	99	**85**
Run-Time Module	250	**225**
Microsoft BASIC Interpreter *for XENIX*	350	**295**
Microsoft QuickBASIC Compiler *full BASICA*	99	**79**
Professional BASIC *by Morgan*	99	**79**
8087 Math Support	50	**47**
RM/BASIC *by Ryan-McFarland*	600	**480**
True BASIC *True BASIC Inc*	150	**119**
Run Time Module	500	**420**
True BASIC Libraries *Btrieve, Asyn, Sort, etc.*	Var	**Call**
C COMPILERS		
C-86 Compiler *Computer Innovations*	395	**289**
Lattice C Compiler *from Lattice*	500	**299**
Let's C Compiler *by Mark Williams*	75	**69**
with CSD Source Level Debugger	150	**129**
MWC-86: Mark Williams C Development	495	**369**
Microsoft C Compiler *4.0*	450	**295**
C INTERPRETERS		
C-Terp *by Gimpel Software*	300	**249**
Instant C *by Rational Systems*	500	**395**
Interactive-C *by IMPACC with debugging*	249	**219**
RUN/C Professional *from Lifeboat*	250	**185**
RUN/C *without Loadable Libraries*	120	**109**
TEXT EDITORS		
Brief *from Solution Systems*	195	**CALL**
Epsilon *by Lugaru Software, like EMACS*	195	**169**
FirsTime *by Spruce Technology, C syntax*	295	**229**
Kedit *by Mansfield, similar to Xedit*	125	**115**
LSE, the Lattice Screen Editor *Multi Window*	125	**100**
Pmate *by Phoenix, with Macros*	225	**159**
Text Management Utilities *Grep, splat, diff, etc.*	120	**100**
Vedit *by Compuview*	150	**119**
Vedit Plus *by Compuview*	225	**180**
FILE MANAGERS		
Btrieve *by Softcraft, no royalties*	250	**195**
Btrieve Network *by Softcraft*	595	**465**
c-tree *by FairCom — no royalties, source*	395	**329**
dBC *dBASE file manager from Lattice*	250	**195**
with source	500	**390**
dbVista *single user DBMS by Raima*	195	**159**
with source	495	**429**
dbVista *multi-user DBMS*	495	**429**
with source	990	**849**
Opt-Tech Sort *Can sort Btrieve files*	149	**119**
SCREEN DESIGN		
Curses *by Lattice, UNIX screen designer*	125	**99**
with Source	250	**199**
On-Line Help *from Opt-Tech Data*	149	**119**
Panel *by Roundhill, no royalties*	295	**229**
View Manager for C *by Blaise*	275	**209**
Windows for C *Vermont Creative Software*	195	**149**
Windows for Data *includes Windows for C*	295	**259**
ZView *Data Management Consultants*	245	**199**

	LIST	OURS
GRAPHICS		
Essential Graphics *by Essential, no royalties*	250	**210**
GSS Graphics Development Toolkit	495	**399**
GSS Kernel System *by Graphic Software*	495	**399**
GSS Kernel System *for IBM RT*	795	**676**
GSS Metafile Interpreter	295	**249**
GSS Plotting System	495	**399**
Halo Graphics Kernel System	300	**219**
with Dr. Halo II, by Media Cybernetics	440	**299**
COMMUNICATIONS		
Asynch Manager *by Blaise, for C or Pascal*	175	**149**
Greenleaf Communications *by Greenleaf*	185	**139**
Software Horizons Pack 3	149	**119**
UTILITY LIBRARIES		
Blaise C Tools Plus C Tools 2	175	**149**
Blaise C Tools	125	**109**
Blaise C Tools 2	100	**89**
C Food Smorgasbord *by Lattice*	150	**109**
C Utility Library *by Essential, 300 functions*	185	**139**
Greenleaf Functions *by Greenleaf Software*	185	**139**
PforCe *by Phoenix, vast library*	475	**349**
Software Horizons *Packages*	Var	**Call**
TopView Tool Basket *by Lattice, source avail*	250	**199**
Vitamin C *by Creative Programming*	150	**139**
DEVELOPMENT TOOLS		
Code Sifter *by David Smith Software, Profiler*	119	**99**
C-Worthy *by Custom Design Software*	295	**269**
C-Worthy for Network *Menus, help, errors*	495	**449**
Dan Bricklin's Demo Program *Prototyper*	75	**69**
LMK from Lattice *by Lattice, "make" like UNIX*	195	**149**
PC-Lint *by Gimpel Software, after UNIX's "lint"*	139	**125**
PFinish *by Phoenix, EXE performance analyzer*	395	**279**
Plink86 *by Phoenix, Overlay Linker*	395	**279**
Plink86 Plus *Utilizes memory for overlays*	495	**359**
Pmaker *by Phoenix, like UNIX "make"*	195	**149**
Pre-C *by Phoenix, UNIX "lint"-alike*	395	**279**
Pfantasy Pac *six Phoenix products*	1295	**895**
OTHER TOOLS		
BASTOC *by JMI, convert BASIC to C*	495	**399**
BASIC-C *BASIC's functions added to C*	175	**139**
The HAMMER *by OES Systems*	195	**179**
PASM86 *by Phoenix, Macro Assembler*	295	**219**
PTel *by Phoenix, Binary File Communicator*	195	**149**
Rtrieve *by Softcraft, Btrieve Report Generator*	85	**75**
Xtrieve *by Softcraft, Query Utility for Btrieve*	195	**175**
FORTRAN COMPILERS & UTILITIES		
ACS Time Series *by Alpha Computer Service*	495	**469**
Forlib- Plus *by Alpha Computer Service*	70	**59**
Microsoft FORTRAN *Links with Microsoft C*	350	**219**
Microsoft FORTRAN *for XENIX*	495	**389**
Pro FORTRAN *by Prospero*	390	**345**
RM/FORTRAN *by Ryan-McFarland*	595	**399**
Scientific Subroutine Library *by Peerless*	175	**149**
Scientific Subroutine Package *by Alpha*	295	**269**
The Statistician *by Alpha Computer*	295	**269**
Strings & Things *by Alpha Computer*	70	**59**
OTHER LANGUAGES & UTILITIES		
Microsoft COBOL Compiler	700	**499**
Microsoft COBOL Compiler *for XENIX*	995	**795**
Microsoft COBOL Tools *with Source Debugger*	350	**259**
Microsoft COBOL Tools *for XENIX*	450	**333**
Microsoft Lisp *New Common Lisp*	250	**189**
Microsoft MuMath *Includes MuSimp*	300	**199**
Microsoft Pascal Compiler *Links with M'soft C*	300	**199**
Microsoft Pascal Compiler *for XENIX*	495	**415**
Pro Pascal *by Prospero, ISO Validated*	390	**345**
RM/COBOL *by Ryan-McFarland*	950	**675**
RM/COBOL 8X *ANSI 85 COBOL*	1250	**995**

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INTERACTIVE–C NEW!

Compiler-Compatible Interpreter, Editor, Debugger

Earlier C interpreters were miraculous compromises. Interactive-C™ shows *how far* C interpreters have come. More than an interpreter, Interactive-C is a fully-integrated development environment: a complete K&R interpreter bound tightly to its own editor and debugger.

Slice through programming projects like a hot knife through butter. Extensive error-checking insures immediate detection of program misbehavior. State of the art debugging tools include breakpoints, watchvalues, several stepping options and interactive viewing and modification of variables. An Interactive-C exclusive lets you interrupt to edit and "continue" from where you left off. Eliminates plodding replays of already debugged code — the ball and chain of other interpreters.

Operate Interactive-C using adjustable edit, command, and status windows. Toggle a second screen showing only your program's output — never any crowded intermixing. Or, boost productivity with twin CRTs. Load object code of functions you have already compiled. Or of commercial libraries. Interactive-C has immediate mode, syntax checking both as you type and run, and cursor positioning precisely pointing at an error, not possible with incremental or pseudo-compilers which leave source code behind.

100% compiler compatible — right down to header files and library calls. Port programs between Interactive-C and your compiler with no modifications whatever — not even tricky areas of dynamic memory allocation and I/O.

Specify:	List:	PC Brand:
E950 & Compiler	$249	$219

RUN/C PROFESSIONAL

C Interpreter Links Binary Libraries

Run/C comes in an apprentice and pro version. The professional model dynamically loads and unloads multiple binary function libraries like C-Food Smorgasbord™ and Halo Graphics™ — potentially any library compiled with Lattice's large model. Inside this interpreter your C program can reach for functions in the best of commercial libraries.

This C interpreter behaves like PC BASIC meets WordStar® . Use fullscreen editing to create a program. RUN it. If it stumbles, LIST it, EDIT it, RUN it again, fix it again. Use familiar commands like LOAD, MERGE, SAVE, FILES, even TRON and TRACE.

Ideal for program development. Put up code at high speed, try out things devil-may care, let RUN/C find your malaprops. Blast away until tight little code segments are undyingly faithful.

Lots more features: system interrupts, a shell command to invoke any operating system command without leaving Run/C, debugging aids ingeniously installed as a Run/C function. Call for debugging conditionally from within your program, a specific function or a menu of aids including immediate mode, single-step tracing, changing of variable values.

Manual shows how to develop the interface to a commercial library, using the Lattice compiler (a must!). Link your own function archive the same way. (320k minimum; 512k recommended to fit libraries.)

Ask for: S0950 List: $250 PCB: $185

PLINK86 & PLUS

Cached Overlays Maximize Memory Use

Long the overlord of overlay linkers, standard Plink86 shoehorns large programs into small machines by sharing memory, swapping program segments in from disk. A 512k program could run in a 128k machine, for example. The Plus version goes beyond: if it finds itself in a larger machine, it moves whatever program overlays that fit into leftover memory. Overlays now swap at memory speed not disk speed. It also can automatically restore a displaced overlay to which a subsequently called overlay must return, and assign library modules to a program's root segment or its overlay areas.

Plink86-Plus: List: $495. Us: $359. Plink86: List: $395. Us: $279

LATTICE C COMPILER

Major Upgrades to the Best Selling C Compiler

Lattice now embraces key UNIX™ enhancements which have entered the language since K&R: void functions returning no value, enumerated data types to assign stepped values to variables, data passing between structures by assignment.

The greatly expanded libraries (325 functions!) enable the file sharing and record locking provisions of DOS 3.1, provide a full complement of transcendentals, and a host of utilities to mimic the UNIX and XENIX™ environments.

Lattice 3.0 defaults to the ANSI proposed standard when you need strict adherence, but command line options restore leniency. And it adopts ANSI checking of external function arguments by data type to kill bug swarms when modules join up at link time.

Lattice now delivers smaller .EXE files, boasts very fast link times and a more efficient aliasing algorithm. New options generate code to use 80186 and 80286 features; 8087 of course sensed and utilized. Lattice has enjoyed pre-eminence so long that developers have created far more snap-on tools for Lattice C than any other compiler. William Hunt's *PC Tech Journal* review of 12 compilers awarded Lattice the only "very good" rating for add-on library availability.

Ask for:	List:	PC Brand:
S0100	$500	$299

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BETTER BASIC

Convert Microsoft BASIC. Structured, Compilable.

Combines the familiarity of BASIC with the best features of C, Pascal, and Modula 2, yet BetterBASIC is 100% compatible with Microsoft's GW™ BASIC and IBM BASICA including graphics, sound, and assembly language calls. So load your old programs and RUN. SAVE and they are converted automatically to BetterBASIC!

It's big: Needs 192k; programs can go to the PC's full 640k. It's comfy: Behaves like M'soft BASIC at the interactive level, with a full-screen editor, direct statement execution, and always poised to RUN. It's fast: Each statement checked and compiled once, not every time encountered. Sieve runs *6 times faster* than with M'soft.

C-like structures house file records so goodbye to FIELD, MKI$, CVD, LSET, etc. Named "procedures" replace GOSUBs to linenumbers. Lots more features: built-in linker for compiled modules; trace; debugging breakpoints; cross-reference command; 32k strings; DOS and BIOS calls and interrupts; recursion. Run-time module stores object code for redistribution.

Ask for::	List:	Us:
S1200 BetterBASIC	$195	$165
S1201 Run-time Module	$250	$225
S1202 8087 Interface	$ 99	$ 85
S1205 Btrieve Interface	$ 99	$ 85

GSS GRAPHICS SYSTEM

Leave the Device Driving to GSS ANSI CGI STANDARD!

GSS™ has reconfigured two components of its comprehensive graphics tools to conform with the ANSI Computer Graphics Interface (CGI) standard.

At the heart of the system is the Development Toolkit which contains all language interfaces and device drivers for keyboards, mice, joysticks, tablets, printers, plotters, cameras, and more. Drivers house management of vector graphics (plotters) and bitmaps used by raster input devices (scanners) to insulate the application program from concern for device idiosyncracy. No one else has implemented CGI that way. It means your programming remains generic; just switch drivers and the same program will drive a different device.

GSS Kernel™ conforms to level 2b of ANSI's Graphical Kernel System (GKS) and contains all its needed drivers and language bindings. Kernel has macro level tools to draw and color an object, store the sequential instructions, and recreate the object on its own, as well as segment it, transform it, etc. So powerful, a single command may represent several score lower level statements.

Plotting has the equivalent GKS tools for graph and chart generation and their captioning: hand it apples and oranges, say "pie", and it bakes the numbers into a digestible display for screen or plotters.

Kernel and Plotting have tools to convert images they create to ANSI Computer Graphics Metafiles (CGMs), a tokenized standard for storing every form of graphic image as data. The Metafile Interpreter reads the contents of a CGM and interprets it with full CGI capability for re-creation on various devices.

Quality software? IBM thinks so. They sell the GSS series under their own label.

Unit royalties and annual fees have been instituted for redistribution. Needs 256k.

Ask for:	List:	PC Brand:
GS010 CGI Dvlpmt Toolkit	$495	$399
GS020 Kernel System	$495	$399
GS025 Kernel for IBM RT	$795	$676
GS030 Plotting System	$495	$399
GS040 Metafile Interpreter	$295	$249

BTRIEVE ASK ABOUT XTRIEVE & RTRIEVE

Queen B-tree File Manager Abdicates Royalties

There's no longer a tithe to incorporate Btrieve™ in applications, a welcome proclamation if royalties would ruin your profit margins. Btrieve takes complete charge of all file creation, indexing, reading, writing, insertion, deletion, space recapture, forward and backward searching. It builds function call "commands" right into the language you use: interfaces to C, Pascal, BASIC, and COBOL, with sample programs in all four, come with each copy.

Btrieve has mainframe specifications! Its balanced-tree indexing scheme finds any key in a million in four or less accesses. Files may have up to 24 indexes; fixed record length to 4090 characters; indexes up to 255 characters; files of 4 billion bytes. Can even extend a file across two drives — even two hard disks!

Version 4.x speeds DOS interaction for large multiply-keyed files; enables variable length records of virtually any length; verifies accuracy (optionally) with read after write, useful in gritty environments; offers password and data encryption.

There's also Xtrieve, for Btrieve file inquiry and data manipulation, and Rtrieve for report writing. All three in versions for any network that supports the MS-DOS 3.1 file sharing function.

Ask for:	List:	PC Brand:
S0650	$250	$195
S0652 Network Version	$595	$465

TERMS AND CONDITIONS OF SALE

Licenses: Each price is for a license to use a product on a single computer and does not constitute its ownership. We will inquire for you about site licenses. Except as otherwise indicated or where "#" follows the Product Code, products may be used to create programs for distribution without royalty payments or additional licenses, provided said programs do not substantially replicate the products themselves.

Compatibility: PC BRAND's standard products are designed to operate with the IBM® PC, XT or AT under PC-DOS and require no more than 128k of RAM unless indicated. Non IBM machines using MS-DOS: contact manufacturer about precise differences so we can advise.

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Payment: We honor MasterCard, Visa, American Express (no surcharge), checks in advance, or funds wired to PC Brand, c/o Chemical Bank, 126 East 86 St., New York, Account 034-016058. COD (U.S. only) for cash, money order, certified check (no fee). NY State, add sales tax. Purchase orders accepted from larger corporations and institutions at our discretion if you agree to net 30 days plus 2% a month late penalty thereafter.

Shipping & Handling: U.S.: UPS Surface: 1st product $6, each add'l $3. UPS 2nd Day Air: 1st product $10, each add'l $4.50. UPS Next Day Air or Federal Express 1-2 Day Air: 1st product $18, each add'l $6. FedEx Next Day 10 AM: 1st product $28, each add'l $7. International: Charges vary by destination and carrier. $10 per shipping container for export forms. Air parcel post at your risk beyond collected insurable amount.

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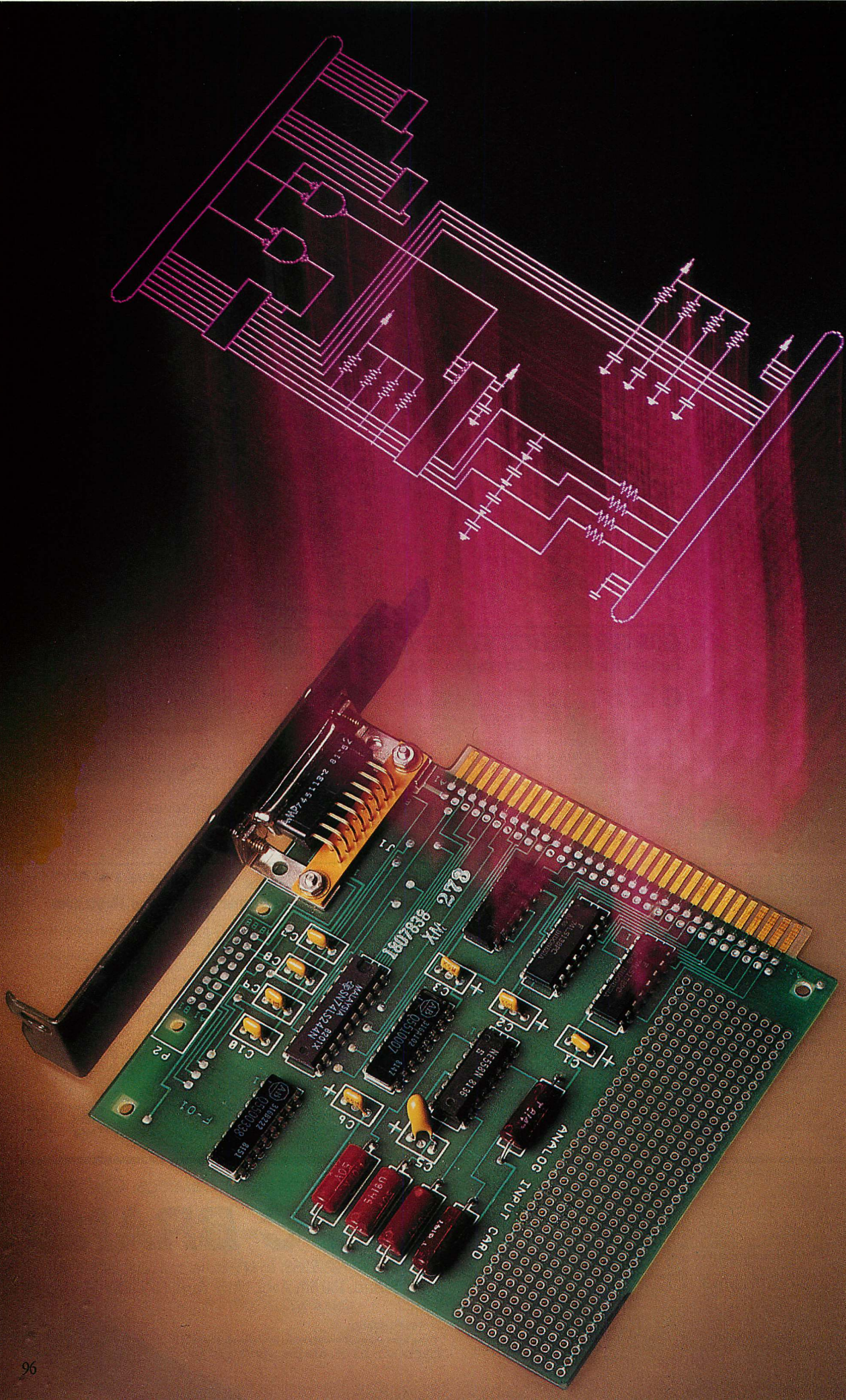

ANALOG INPUT CARD

End-to-End Design

PCB-3 from P-CAD is a complete design system for generation and conversion of electronic schematics through placement and routing of printed circuit boards.

RICHARD ANGELL

Software products that capture schematic designs, design printed circuit boards (PCBs), and support design documentation are a significant force in the CAD market. Pioneers in the under-$30,000 PC workstation segment have been offering such products on microcomputers for years. One of these pioneers is Personal CAD Systems, Inc., or P-CAD, and considered here is its end-to-end PCB design product, PCB-3 (version 1.3). This system integrates the major electronic CAD elements, including schematic capture; net list transfer; PCB placement editor, layout editor, and autorouter; and back annotation. PCB-3 runs on the PC/XT, PC/AT, and compatibles and supports a range of CAD hardware configurations. It offers many flexible features, but its limitations determine its place in a production CAD environment.

An end-to-end system is one that automates the process of creating PCB designs from schematics. This entails developing a schematic and extracting the connection and device data to create the initial PCB data. Further along it means placement of parts, editing and routing the PCB, and producing documentation and film plot data, as well as generating parts lists and other reports. The system should accommodate normal changes, such as pin, gate, and part exchanges, in addition to reference designator renumbering. The change reporting and incorporation process (back annotation) is used to make the schematic agree with the actual PCB design.

PCB-3 is a layer-oriented, menu-driven CAD system. The layering system can be visualized as a series of transparent sheets that together make up the complete drawing. The PCB-3 system, however, has elements that permeate all layers; thus, it is more than simply a stack of plastic sheets.

The system consists of the two main editors—PC-CAPS for schematics and PC-CARDS for PCBs—and 12 utilities (see table 1). A simplified PCB-3 system flow is shown in figure 1. PC-CAPS, net list processing, packaging, and the documentation utilities are given attention here; a subsequent article will examine PC-CARDS and P-CAD's PCB design programs.

Generally speaking, the required symbols are copied into a schematic database, using PC-CAPS, where the symbols are wired together and notes are added. The schematic net list is extracted by PC-NODES, then the symbols are packaged as a PCB database by PC-PACK. PC-PACK also creates annotation files that supply reference designators and pin numbers for use by PC-CAPS and PC-FORM, the report generator.

This PCB database is loaded into PC-CARDS where the PCB outline is added and the parts placed within the outline. Then PC-PLACE processes the database for placement optimization. The result is processed through PC-

PHOTOGRAPH • MARC DAVID COHEN

ROUTE to route most or all of the design automatically. The "autorouted" database is loaded into PC-CARDS for manual completion. The final design is checked with PC-DRC/NLC, the design rule checker. After final modifications with PC-CARDS, film and documentation plot files are extracted. The schematic is back-annotated using PC-BACK and PC-CAPS to add the reference designators and pin numbers to the schematic. Final schematic documentation plot files are extracted using PC-CAPS.

The system treats electrical intelligence separately from graphics data, and thus facilitates error checking, net list extraction, routing (continuity) verification, and so on. With PCB-3, the commands to enter data that must have electrical intelligence are selected separately from those that create graphics—unlike manual methods where no distinction is made on the drawings.

This automated method is accomplished in part through *intelligent pins*, which permeate the layers of the database (see figure 2). The pins themselves are reference points for individual pin information and are used in a symbol file as reference points for symbol and packaging information.

Pins usually are associated with a part or symbol, but can be entered into a database as single entities. The pin intelligence in PCB-3 is generated in three ways: by using attributes to describe pin and part properties, such as input, output, or both signal directions; by designating a pin type for assigning overlay graphics and data; and by assigning pin groups that enable swapping in the PCB layout. Symbols can be packaged as gates, then attributes can be added to the representations. These data can be used for automated preassignment and full back annotation of reference designators, gate sections, or entire components—creating a powerful CAD system. One of the facilities of this system is its error checking, which would not allow, for example, the placement of coincident pins.

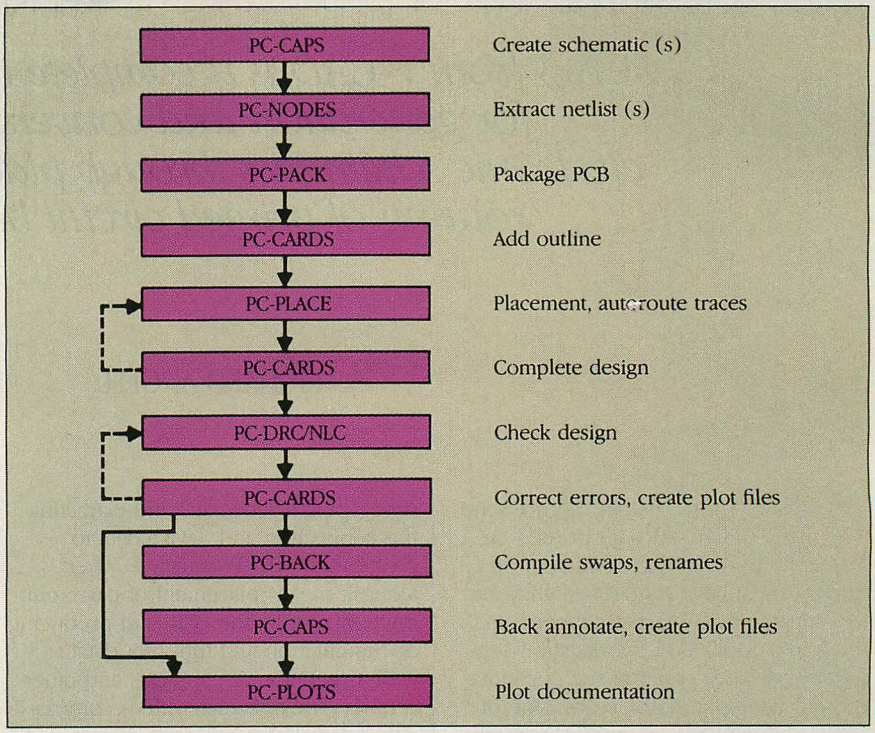
In structuring, PCB-3 treats each database as an element that exists in a specified environment with *symbol* and *detail* features. The environment includes the layer structure and pens (colors) assigned to each layer, layer viewing status, active layer, grid size, grid units, line style and width, text size, rotation, mirroring status, and other pertinent features as set when the database was last saved. The environment is a specification that the user can supply, although a system default is loaded each time the editor is invoked.

TABLE 1: *PCB-3 System Program Elements*

PROGRAM	FUNCTION
PC-CAPS	Schematic capture program
PC-NODES	Net list extraction utility
PC-LINK	Net list linker/compiler utility
PREPACK	Cross-reference packaging library compiler
PC-PACK	PCB packaging utility
PC-CARDS	PCB editor program
PC-ROUTE	PCB autorouting program
PC-DRC/NLC	PCB design rule and net list continuity checking utility
PC-BACK	Back annotation file generator utility
PC-PRINT	Plot file conversion for dot matrix conversions utility
PC-PLOTS	Plot file to pen plotter driver utility
PC-PHOTO	Plot file to photo plotter file creation utility
PC-FORM	Net list to report file generator utility

In the PCB-3 system, the main program editors, PC-CAPS and PC-CARDS, are used to produce the schematic and printed circuit board layout, respectively.

FIGURE 1: *Simplified PCB-3 System Flow*



The accuracy of the automated approach offered by the PCB-3 system is a clear improvement over manual methods of producing PCBs from schematics.

The symbol section of the primary database keeps track of all data input to a database while in the SYMB (symbol) mode available in both PC-CAPS and PC-CARDS. Similarly, the DETL (detail) data includes all the subcomponents (symbols or parts), nets, attributes, and annotations entered in the DETL mode either directly or via the subcomponents data records.

This use of the SYMB and DETL relationship permits hierarchical designs when required; a hierarchy consists of detailed circuit elements that have a separate symbolic representation used to build the next higher detailed circuit elements. The lower levels of the hierarchy can be examined at any time by using the PUSH command. The POP command returns the user to the next highest level of hierarchy.

PCB-3 SPECIFICATIONS

The main PCB-3 software routines are written in C; some of the drivers are in assembly language. PC-CAPS and PC-

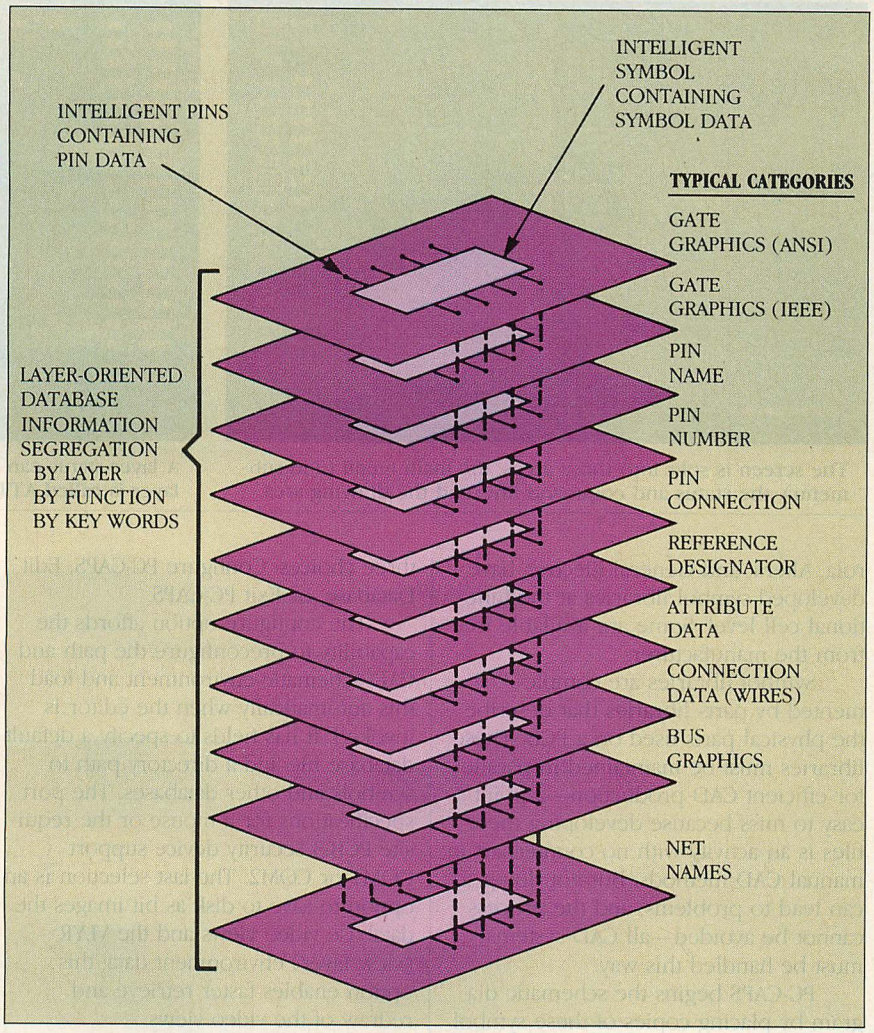
CARDS use all 640KB of RAM, which prevents the use of any memory-resident utilities such as Borland's SideKick or SuperKey; also, most of the main program and the current database are kept in RAM. The system uses paging schemes where necessary. The performance of overlay programs is sometimes less than satisfactory; however, P-CAD has added a twist that really makes a difference—video image files of the layer structure table and assignable graphics views can be saved to disk and recalled as needed. Loading and displaying the views from disk can be more efficient than reconstruction from the main database in RAM.

If the system continually goes into paging during use, the problem could be that too many ancillary data are being incorporated into the database with each library entity. It makes more sense to use symbol and part files with only the essential information during operation. The supplementary data can be added by post-processing the parts list with an external database system. Otherwise, the database will slow down (due to paging) as the limits of the database size are reached.

A PC-CAPS schematic database is limited to 500 components, with no more than 300 component types; 600 nets; 2,500 pins with 2,100 pins in the memory buffer; and 3,500 picture groups (graphics data) with 3,500 in the memory buffer, or 48,000 picture elements with 16,000 in the memory buffer. Program segmentation into functional modules for the main tasks allows them to work more efficiently within the host limits.

The PCB-3 system comes with a box of system diskettes, manuals for each of the major programs, a utilities manual, an empty binder for library manuals, an installation guide, a system overview book, and a large wall chart that maps the system flow in detail. The system installs using Autoloader and Install. Autoloader is a sequential, prompt-driven program that creates the necessary subdirectories on the hard disk (if not already present) and loads the files into the appropriate directory as the user feeds each PCB-3 disk. Then, by running the Install program, a file called PCADDRV.SYS is created in the root directory. This ASCII file can be edited, but running Install again will overwrite it. The unused drivers can be deleted manually. The directory names generated by the PCB-3 system, EXE, PRT, SYM, and DRV, relate to the filename extensions of the majority of files loaded in these directories.

FIGURE 2: *Typical Database Layers*



The concept of splitting the various parts of the symbols onto separate layers is different from manual methods. This is necessary to aid the transfer of the *intelligent* data in the form of wires from the schematic to the other program modules.

The full system map illustrates the multiple paths accommodated by PCB-3. The system flow begins with the creation of a schematic using PC-CAPS, which is used to generate both the electronic schematic symbols, depicting components or parts of components, and the detailed schematic diagrams.

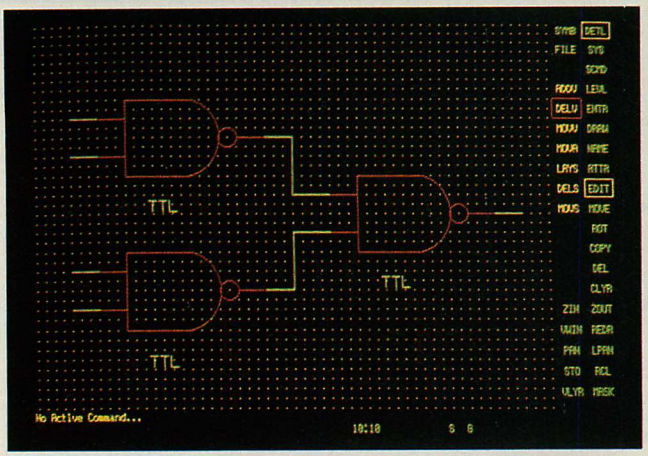
The system uses the hard disk during operation of the major programs to maintain command log files of the key strokes and command entries in case of error or system failure. These ASCII files can be edited and played back as macro command files to reconstruct sequences of work that may have been lost otherwise. They also serve as models for constructing macro command files to create symbols or parts more efficiently. This version has two levels of backup for reconstructing the last two sessions. Automatic backup can be disabled by a keyboard command.

OFF-THE-SHELF LIBRARIES

Every database contains the graphics and the electronic and physical part packaging relationship data necessary to accomplish end-to-end design. The symbols created using PC-CAPS are stored as separate files, one for each graphic representation, and a separate symbol file must be created for each version of a symbol. For example, the normal and demorganized forms of a 7400 NAND gate each would require a separate symbol file. A group of symbol database files is a *symbol library*.

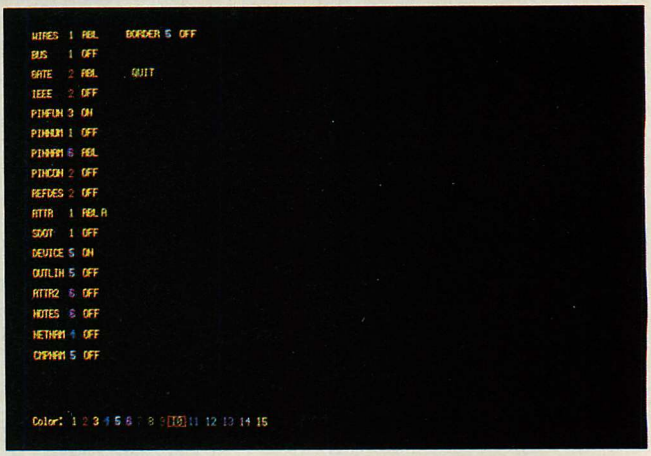
P-CAD offers off-the-shelf libraries for TTL, CMOS, Intel, and Motorola microprocessors, discrete device symbols, and linear integrated circuits (ICs), ranging in price from $150 to $300 for a symbol or a parts library; the Motorola Gate Array libraries are $500 per technology. Many custom chip manufacturers, such as Texas Instruments, Moto-

PHOTO 1: *PC-CAPS Main Screen*



The screen is split into three areas: the main menu (and sub-menu), the status and command line, and the drawing area.

PHOTO 2: *PC-CAPS View-layer Screen*



A layer status can be ON, OFF, or ABL. The current active layer is called ATTR, with the A appearing after the ABL.

rola, Altera, and General Electric, have developed symbol libraries at the functional cell level. Some are available free from the manufacturer.

Symbol libraries are complemented by parts libraries that describe the physical parts used on a PCB. These libraries must be maintained in parallel for efficient CAD production—a point easy to miss because developing these files is an activity with no counterpart in manual CAD methods. But not doing so can lead to problems, and the process cannot be avoided—all CAD systems must be handled this way.

PC-CAPS begins the schematic diagram by placing copies of these symbol library files into a schematic database along with graphic, intelligent connection data, called *wires*, and annotation information. The wiring connections on the schematics identify each group of component pins hooked together with one common wire as a distinct entity, a *net*. Each wire or group of wire segments with the same net name is treated as that net. Even bus structures are nothing more than intelligent wire segments with the same net name attributes that have been connected by a drawn, nonintelligent line representing the bus highway.

The editor also can create user-defined connection (solder) dot files, used as overlays for plotting. Schematics consist of one schematic sheet per schematic database file. PC-CAPS is used to prepare single-sheet, multisheet, and hierarchical schematic designs.

PC-CAPS OPERATION

Upon invocation, a program title and copyright notice appears. Pressing any key brings up another screen that offers three choices: Configure PC-CAPS, Edit Database, or Exit PC-CAPS.

The configure option affords the capability to preconfigure the path and CAD schematic environment and load this automatically when the editor is invoked. It has fields to specify a default database file and a directory path to symbols and other databases. The port specifications for a mouse or the requisite PCB-3 security device support COM1 or COM2. The last selection is an option to save to disk as bit images the database video views and the VLYR (view layer) environment data; this option enables faster retrieve and redraw of the video views.

Changes can be made for the current session only, or, configuration changes can be saved permanently in PCCAPS.CFG by saving the file when prompted to do so on the screen.

The Edit Database selection invokes the main editor portion of PC-CAPS. If the security device has been installed, then the main PC-CAPS editor screen (shown in photo 1) appears. The two-column command menu on the right has three main areas that cover system and mode, database operation, and video control/data type masking. A two-line message/command entry and status line area are located at the bottom of the screen, which frames the main drawing window.

Table 2 lists the commands available in this menu. The PC-CAPS manual provides an explanation of each command, along with error messages that may be issued from improper use or use of a command at the limits of the system. The majority of functions offered by P-CAD editors are correlated to similar functions performed manually.

Many of the commands nest and repeat until another command is chosen. This is a great convenience—having to go to the menu to select, for example, ENTR/WIRE each time a wire is added would be an unnecessarily repetitious operation.

P-CAD provides special editing commands for wires and drawn lines. Some initial commands, such as MOVE, ROT (rotate), COPY, DEL (delete), CLYR (change layer), and the optional WIN (window) and IDEN (identified) objects, permit editing work. These actions, however, are crude for the majority of line and wire editing the user will be doing, so the EDIT command set is also available. This set allows the user to manipulate wires or drawn lines by adding vertices, moving or deleting vertices and segments, and changing the layer of a segment.

The system also handles data for single objects, windows of objects, or identified collections of objects. In addition, rubber-banding is supported where appropriate. When moving objects, a highlighted representation is shown for ease of placement.

When the PC-CAPS SYMB mode is invoked, the menu displays as red; when the system is in DETL mode, the menu displays in green. Selections from the menu or changes to the status line are made by moving the cursor from the main display using a mouse, or a digitizer, or the cursor or function keys, and then pushing the execution key—button 1 on the mouse, the space bar on the keyboard. (Table 3 lists the actions available.) PC-CAPS also supports direct keyboard entry of commands. (Table 4 lists commands entered only from the keyboard.)

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TABLE 2: *PC-CAPS Command Set*

MAIN COMMAND	SUB-COMMAND	SYMBOL MODE	DETAIL MODE	MODE RETAINED[a]	DESCRIPTION
SYMB		●	○	○	Sets symbol mode environment
DETL		○	●	○	Sets detail mode environment
FILE	SAVE	●	●	○	Saves current file
	LOAD	●	●	○	Loads a file into RAM
	ZAP	●	●	○	Clears current database memory
SYS	DOS	●	●	○	Limited DOS shell: CD, CLS, COPY, DATE, DEL, DIR, ERASE, FIND, MD, PATH, REN, RD, SET, TIME, TYPE, VER, VOL
	PLOT	●	●	○	Prompts for opposite corners of a plot window and the plot path/file name
	STAT	●	●	○	Displays statistics for current database
SCMD	SCAT	●	○	○	Prompts for component attribute number; used for reference designator, simulation, package status
	SPAT	●	○	○	Prompts to set or modify the pin type (I, O, I/O) and pin logical equivalency group number
	PNLC	●	○	○	Prompts to set number of gates per part, number of pins per gate, reference designator and pin number locations with layer and text attributes
SCMD	SNAT	○	●	○	Prompts to set global net attribute (for example, PWR or GND); for named nets in hierarchies
	PNUM	○	●	○	Prompts to preassign reference designator and section pin numbers to PNLC locations on symbols
	GSSF	○	●	○	Calls user-defined solder dot graphics
LEVL	PUSH	●	●	○	Moves down hierarchy one level
	POP	●	●	○	Moves up hierarchy one level
ENTR	PIN	●	○	●	Prompts for the pin location, pin name location, and pin name; allows nonplacement of name
	ORG	●	○	○	Enters symbol (*0,0*) as location reference point for symbol
ENTR	COMP	○	●	●	Prompts for symbol file name and then position, allows scaling of symbol in *X* and *Y* axis rotations and mirroring
	WIRE	○	●	●	Prompts user for points on wire to be entered, assigns default net name automatically, checks for shorts or merges during input, allows style and width variables to be changed, entry by pointing or direct coordinates
	UCOM	○	●	●	Uncommits a pin from a placed net
DRAW	LINE[b]	●	●	●	Same as WIRE, without net intelligence; user selects layer for placement
	RECT[b]	●	●	●	Prompts for opposite corners, draws rectangle
	FREC	●	●	●	Same as RECT; filled rectangle on display only
	CIRC[b]	●	●	●	Prompts for center and radius points, draws circle
	ARC[b]	●	●	●	Prompts for center, radius, and end point
	TEXT	●	●	●	Prompts for location and text string, size, orientation, justification, and mirroring can be set
NAME	COMP	○	●	●	Prompts to select component symbol and enter name (reference designator)
	NET	○	●	●	Prompts to select net and enter name, checks for violations and prompts for merges
ATTR	SCHG	●	●	●	Prompts to select and change attribute
	ACOM	●	●	●	Attributes a component or whole schematic
	DATR	●	●	●	Prompts to select and delete an attribute

LAYER SPECIFICS

Issuing the VLYR command produces a screen that shows layer structure and status (see photo 2). Each layer has a name, a selected pen color, a display status, and a current status display. PC-CAPS accommodates as many as 50 layers; layer names can have a maximum of six characters.

The system allows 1 of 15 pen numbers to be selected for each layer (the 16th color is the background); the pen numbers are displayed as separate colors according to a certain graphics driver/monitor set-up. If fewer than 16 colors are supported, the pen number colors available are put into an ordered, repeating set. This does not inhibit the ability to plot in 15 different colors because it is the pen number, not the display color, that is the intelligence passed to the plotter.

Layer status possibilities are OFF, ON, or ABL (abled). An ABL status places the layer in a queue of ABL layers, one of which becomes the immediate layer for direct entry actions. The immediate layer is identified with an A following the ABL status. From the main editor, any layer with a current ABL status may be made the immediate layer by function key toggle or by selecting the layer name entry on the

MAIN COMMAND	SUB-COMMAND	SYMBOL MODE	DETAIL MODE	MODE RETAINED[a]	DESCRIPTION
EDIT	ADDV	●	●	●	Adds a vertex
	DELV	●	●	●	Deletes a vertex
	MOVV	●	●	●	Moves a vertex
	MOVA	○	●	●	Moves whole wires only
	DELS	●	●	●	Deletes a segment
	LAYS	●	●	●	Changes the layer of a segment
	MOVS	●	●	●	Moves a segment
MOVE		●	●	●	Invokes subcommand menu and can be used to move single objects, except wires
	WIN	●	●	●	Prompts to define a rectangular window of objects for moving, stretches wires not entirely in the window, moves net names on moved wire segments
	IDEN	●	●	●	Prompts to select objects, except wires, to be moved
ROT		●	●	●	Invokes subcommand menu and can rotate single objects in 90-degree increments from user-defined origin
	WIN	●	●	●	Prompts to define a rectangular window of objects for rotation in 90-degree increments from user-specified origin
	IDEN	●	●	●	Prompts to select objects to be rotated in 90-degree increments from user-specified origin
COPY		●	●	●	Invokes subcommand menu and can be used to copy single objects, WIRE COPY deletes net associativity
	WIN	●	●	●	Prompts to define a rectangular window of objects for copying
	IDEN	●	●	●	Prompts to select objects to be moved, does not observe the MASK command settings
DEL		●	●	●	Same as COPY, except performs deletes
	UNDO	●	●	○	Additional subcommand, undoes last delete action, does not apply to EDIT/DELS actions
CLYR		●	●	●	Same as COPY except performs change layer actions to selected layer
ZIN[cd]		●	●	○	Zooms in, selects center of new view
ZOUT[cd]		●	●	○	Zooms out, selects center of new view
VWIN[d]		●	●	○	User defines rectangular view to display
REDR[d]		●	●	○	Redraws the display
PAN[cd]		●	●	○	Pans display window, selects center of new view
LPAN		●	●	○	Produces screen for selecting long range pan in the database
STO		●	●	○	Stores 10 user-defined views of the database
RCL		●	●	○	Recalls stored views
VLYR		●	●	○	Views and alters layer structure
MASK		○	●	○	Masks components and/or wires from some command actions

● = *Yes* ○ = *No*

[a] *Command stays in current mode until new command is selected.*

[b] *Line style and width can be selected.*

[c] *Nested command, can be repeated without reselection of command.*

[d] *Can be operated from within other commands.*

PC-CAPS offers three main types of commands. The general system and display commands permit file maintenance and provide environment and attribute settings. The edit commands distinguish among commands used to enter the WIRES and commands for general drawing use. The majority of functions offered are correlated to similar manual functions.

status line and toggling it. An ON status also permits activity, such as edits, but cannot become the immediate layer for direct entry actions; ON does, however, permit deletes. New layers are added by selecting a blank space on the view layer screen. If a layer is turned OFF, nondisplayed items cannot be edited. The WIRES layer is an exception: a wire can be deleted or moved even if the layer is turned OFF.

Symbols can be scaled as they are entered into a database. Sheet size limits can be created with visual queues, such as a border, to provide a template for use as the initial setting for a design. PCB-3's SYS/STAT (system/status) command, invoked directly from the editor, displays the current database size in terms of elements versus limits.

PCB-3 provides user-definable grids with a mix of world grid, scaling, and plotting options. A default 10-by-10-DBU (database unit) grid, which is a snap grid overlaying the 60,000-by-60,000-DBU database, is loaded upon invoking the editor. The user can select and change the snap grid to chosen increments of the world grid. The snap-to-grid and the viewable status of the grid is obtained with a status line toggle.

In PC-CAPS, the layers used in symbol generation are enabled by loading a

file with the layer environment defined. The practice is to ABL the layers used in the symbol creation process in an empty file (with the SYMB mode set and the GATE layer active) and save it as LAYS.SYM. This file is loaded as a beginning file to create new symbols.

PC-CAPS drafting commands are used to create a symbol. The gate graphics are drawn, using the DRAW drafting command set, on the GATE layer of the database. The DRAW set includes LINE (lines), RECT (rectangles), CIRC (circles), and ARC (arcs), with solid, dashed, or dotted lines at 0- to 250-DBU width. (One draw command, FREC (filled rectangle), appears to have no purpose. The command causes a filled rectangle to be displayed at the size entered, but plots a hollow one.)

PCB-3 is not corner-specific in drawing rectangles, but requires only identification of any two diagonally opposite corners. This extends to other operations, including area identifications such as WIN selections of objects. Note that the database treats a rectangle drawn as line segments differently than one drawn with RECT. The one drawn with segments can be altered in size with the EDIT command set, while the other must be replaced with a new RECT to change its proportions. CIRC and ARC figures have the same restriction for change operations.

Text heights of 2 to 5,000 DBUs are available. The text options permit four justifications (combinations of left, right, center, bottom, and top locations for entry), with any of four 90-degree orientations and mirroring. Only one font is currently supported for plotting and display. The text size in the database is not what is plotted: the plotted size is a reduction of text size by a user-controlled set of parameters defined during the plotting process.

Users may draw with either ANSI Y32.2 style graphics or IEEE logic symbols, or both. Most P-CAD symbol libraries have both, and the default layer structure is set up to accommodate both presentations in the same symbol file. This gives the user the flexibility to manipulate the active layers before a plot file extraction to plot either the IEEE or ANSI schematic. Because the symbols are constructed with the pin locations fixed in the same spot for each, the wiring of the schematic serves to hook up pins that can be shown with either standard turned on. This feature adds great versatility with no additional investment. Still, problems can come up because not all ANSI and IEEE shapes can be represented in the same file due to pin location variations between the two.

TABLE 3: *Status Line Adjustments*

CURRENT DISPLAY	SELECTION ACTION
Active layer	Next abled layer
Net name	Select new name
Wire or line type	Next type: SOLID, DASHED, or DOTTED
Wire or line width	Select new width
Text size	Select new size
Text justification	Next justification: left, right, or center and top, center, or bottom
Text orientation	Next degree of orientation: 0, 90, 180, or 270
Text mirroring	Toggle ON or OFF
Snap-to-pin	Toggle ON or OFF
Grid	Select new *X* and *Y* grid units
Grid display status	Toggle ON or OFF
Grid snap lock	Toggle ON or OFF
World coordinates	Select new *X* and *Y* position

The bottom of the screen display is reserved for the status line. The status is changed by toggling through options or selecting the name or size required.

TABLE 4: *Keyboard-only Commands*

COMMAND	ACTION
/CFIL	Command log file: RESTART, turn ON or OFF
/EXE	Execute a command or macro file
/INTR	Interrupt execution of a file
/MAC	Start a macro file
/MEND	End a macro file
/RESU	Resume execution of an interrupted file
/SGAT	Set global attributes for snap-to-pin and net list
/WAIT	Set a pause and message in a macro file

The PC-CAPS macro facility allows sequences of commands to be replayed (from the command log file of the two previous sessions) using some of these commands.

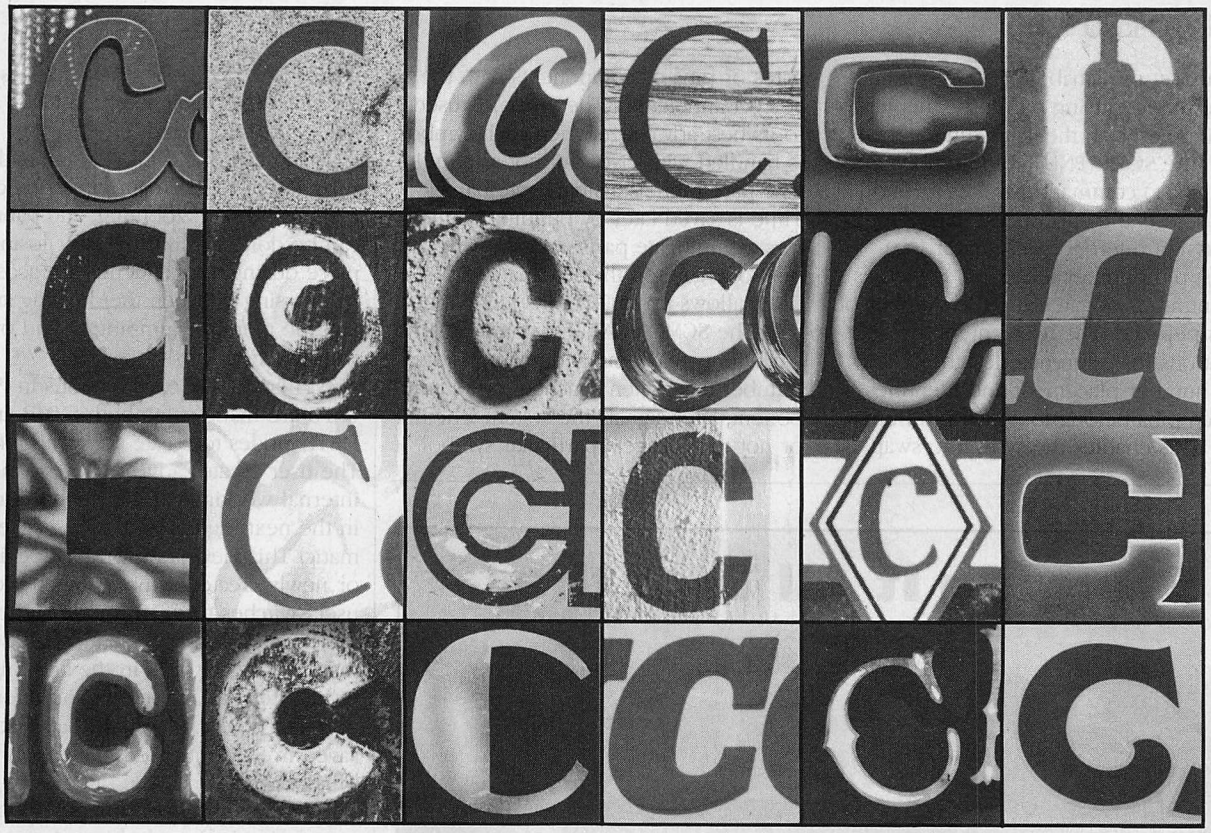
Once the user draws the gate graphics on the GATE (ANSI graphics) layer and IEEE layer, the locations for the pins should be apparent. Most symbol formats have leaders to the pin locations on the graphics layers—leaders that should terminate on a 200-mil grid in most full-size symbol representations. A standard in the PC-CAPS manual guides the creation of symbol graphics to ANSI full-size conventions.

INTELLIGENT PINS

Entering the pins is simple enough. The user selects ENTR/PIN from the menu, points to the preferred location, and presses the mouse button 1. The system asks for a pin name location. In gates, the pin name usually is not included on schematics, so in these instances pressing button 2 will skip the placement and bring a request for the pin name. Otherwise, a location is selected and the pin name is typed in according to the settings of the text attributes on the status line. Barred pin names are supported: the bar is entered by terminating the pin name with an apostrophe. The display and graphics plots will show the bar, but the net lists will display the apostrophe.

Version 1.3 automatically selects the PINCON layer as the pins are entered, then selects the PINNAM layer for pin name entry as each pin is entered in the editor. PC-CAPS permits the selection of new default layers for the current session if the user wants different default layers for pins or pin names. This feature saves time and averts errors. When all pins are entered, PC-CAPS must be instructed where the symbol's origin is using ENTR/ORG.

PCB-3 permits users to attach simulator data about pin type and PCB layout data about pin swap status at the symbol level in the schematic. Pin entry is flexible enough to allow the setting of pin type—I(input), O (output), or B (bidirectional) for simulator use—and equivalent groupings (for PCB pin swaps of electrically identical pins) at that time or later in a sequential entry mode using SCMD/SPAT (system com-



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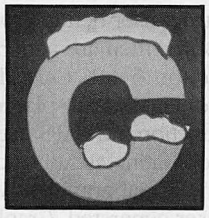

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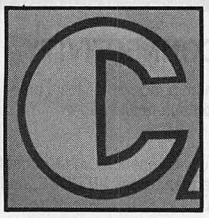

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mand, set pin attribute type). In immediate mode, during pin entry, this information is set on the status line.

The SCMD/PNLC (pin number location code) command invokes a routine that selects the appropriate layers to preassign reference designator locations, pin number locations, as well as the number of gates and the number of pins per gate. The user enters the text locations for reference designator and pin number placement and identifies which pins belong to which pin number. This enables the system to swap gates or pins or components with the correct annotation. The system is used to its best advantage when each symbol is handled with PNLC—if not as a multigate part, then as a single-gate part. Time is saved later by building connectors as multigate parts, and showing only one gate on the schematic. PC-CAPS allows up to 255 pins per symbol.

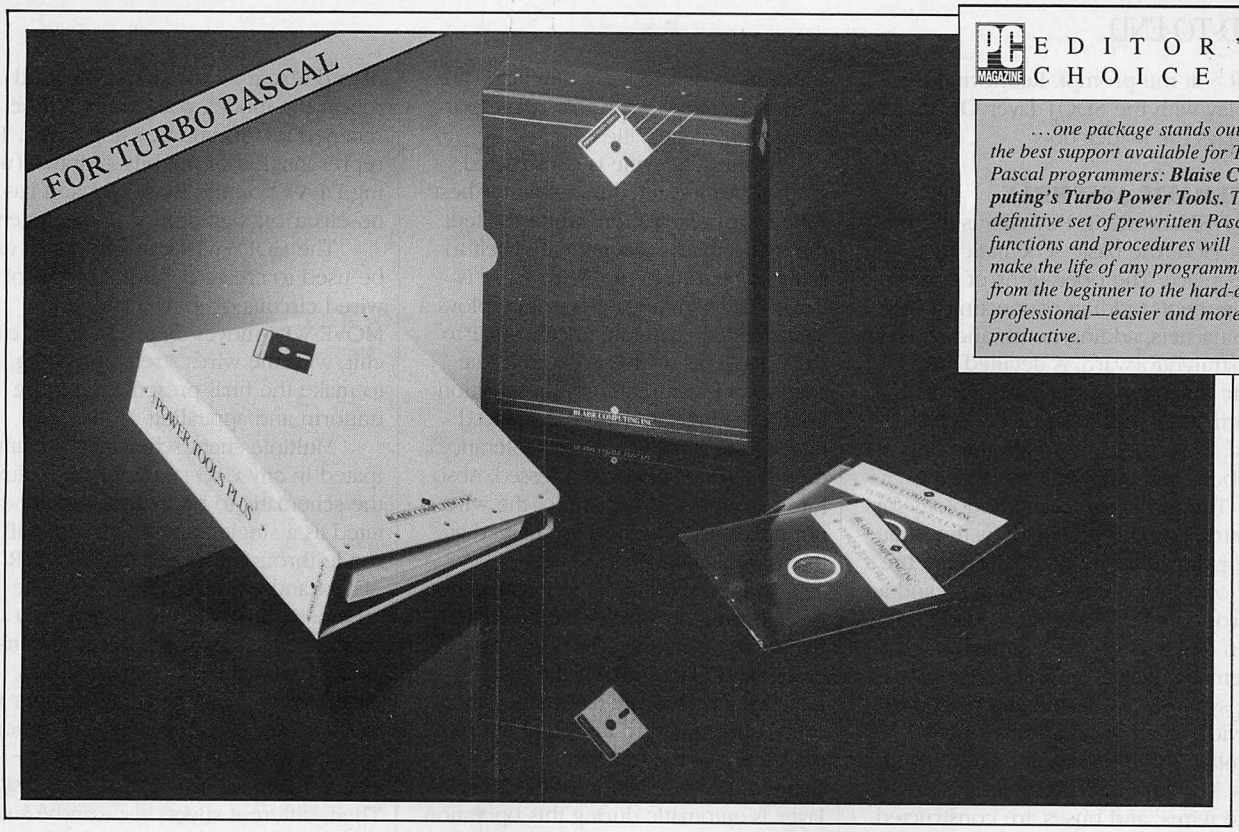
The SCMD/SCAT (set component attribute type) command prompts for a number that, when attached to the component, later signals the system whether or not to package a particular symbol. It is also used for basic reference designator class letter assignment, but not all letters are supported.

The video and mask commands are subservient to the main operating commands. Viewing, zooming, and panning can be done without the user losing his place during a task. Menus are accessed by crossing between the drawing area and the menu or jumping in and out with function keys.

Hierarchical constructions in PC-CAPS are made using both SYMB and DETL modes to create the symbol file. The user creates a DETL view of the internal workings of the symbol for use in the next higher level of the schematic. This view is drawn using existing or newly created symbols. Then the user switches to SYMB mode and constructs a symbol representing the schematic, or a gate of it, in the next higher level. After full annotation and information attachment, the entire database is saved in SYMB mode as a symbol file. This progression is the same throughout the hierarchy, forming a symbol-into-design-into-symbol-into-design chain from bottom to top, with 16 levels available. Thus, the lowest level in the hierarchy is a single primitive gate or component, but the highest level could be a system block diagram.

Each finished symbol is filed using FILE/SAVE, which prompts for a file name. When operating from SYMB mode, if no file extension is supplied, the system adds .SYM, as a default.

SYMB mode also is used to construct user-defined *solder dot* graphics, which then are generated by the main editor to a PC-CAPS default-size dot. Solder dots are placed at every T-wire junction. PC-CAPS uses the SDOT layer (operating as ABL and A, for active) for the actual graphics, whether default or user-generated. Graphics are drawn (using DRAW) to the size and shape desired, then an origin is entered. Solder dots are given a component ID type of 0 to avoid packaging them into a PCB. The solder dot is pure graphics—it has no pin. In order to use it, a special symbol file is created with a text editor. This file contains one line that references pin type 15 (reserved in PC-CAPS for solder dots) to the solder dot file's path\file name. Later under the main editor, these user-defined graphics can be overlaid in the schematic database using a command series SCMD/GSSF and entering the name of the special symbol file in response to a prompt. They can be erased from the database in the same manner, except that no path\file name is given, only a



PC MAGAZINE EDITOR'S CHOICE

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<CR> at the prompt. Redrawing the display with the SDOT layer ON or ABL displays the solder dots.

SCHEMATIC ASSEMBLY

The DETL mode in PC-CAPS is the next stop. Here the basic schematic assembly takes place. The operations of entering components, adding connecting wires, naming nets, adding notes, and so on are straightforward. A detailed schematic diagram is stored as a file with all information related to each symbol used, the wiring information to link the symbols, and any notes or drawings.

The fundamental methodology for constructing the schematic is the same as for drawing one manually. First the size of schematic is determined, and an appropriate template file is loaded. Then the symbols are entered into the schematic database using ENTR/COMP. The symbols are scaled and placed to provide room to add the wiring yet maintain the integrity of circuit groupings. Then ENTR/WIRE enters the discrete wires, and buses are constructed. The nets are named using NAME/NET, although it is convenient to enter the name while placing the wire. Symbols that need preassigned reference designators and pin numbers are identified using SCMD/PNUM. Then any schematic annotations are added. Commands are available to move, copy, or rotate portions of the schematic.

As the schematic is constructed, symbols are oriented in a manner best suited for presentation: when rotated, the text remains reading either left to right or bottom to top. Wire entry is made easy with a feature that employs a user-defined snap tolerance from 1 to 1,000 DBU. As a wire is entered, the snap-to-pin feature allows the position for the end of the wire to be placed near to the pin (within snap tolerance), then the select button is pressed. Absolute placement of the end of the wire is not necessary. The nets are named at this point, using F3.

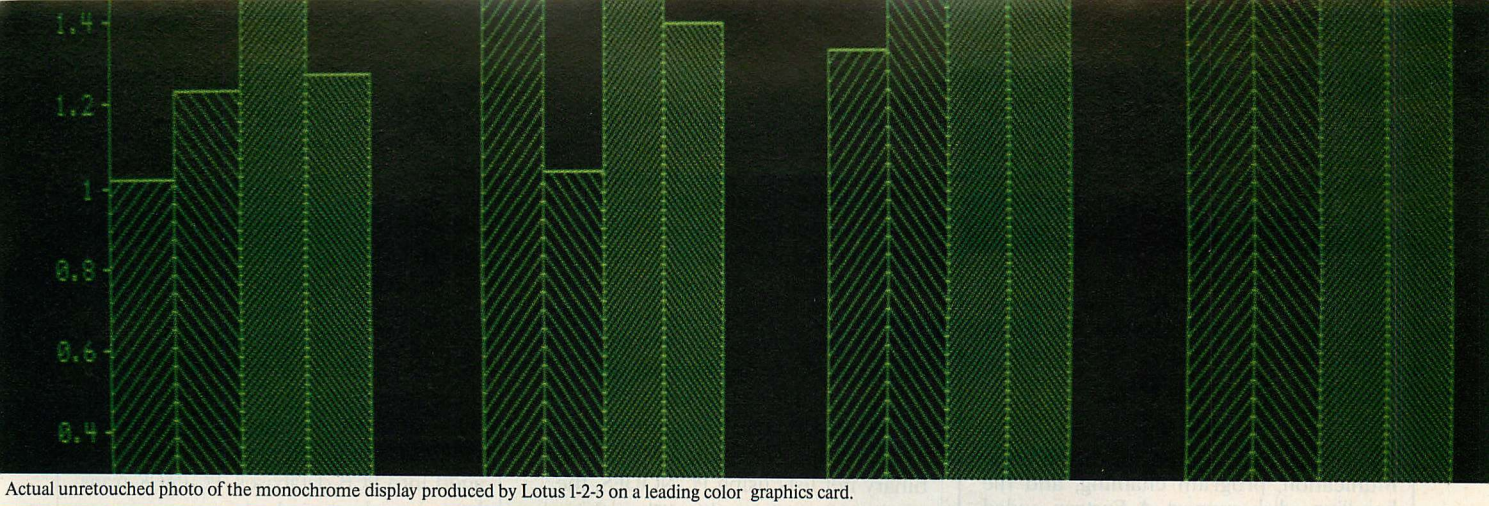
In PC-CAPS, NAME/NET names nets by selecting the wire (which is highlighted to verify the selection), and enters and places text. If the text matches a previously named net, the user is prompted to merge or abort; placement of the text can be suppressed. Layer selection of the NETNAM layer is automatic during this operation. Once a net is named and the text is placed, any copy of that named wire retains the same text placement locations, without text, for later use. With this feature, the user can create a model of the first net in a bus, name it with placed text at all locations, step, and repeat the model, complete with the retained text locations, using COPY. The representation of the bus is drawn (using DRAW) on the BUS layer and has no electrical significance in the system.

The COPY/WIN command also can be used to create duplicate blocks of wired circuits or their wires only. MOVE/WIN moves a portion of the circuit, with the wires stretching along, to make the final presentation more uniform and appealing.

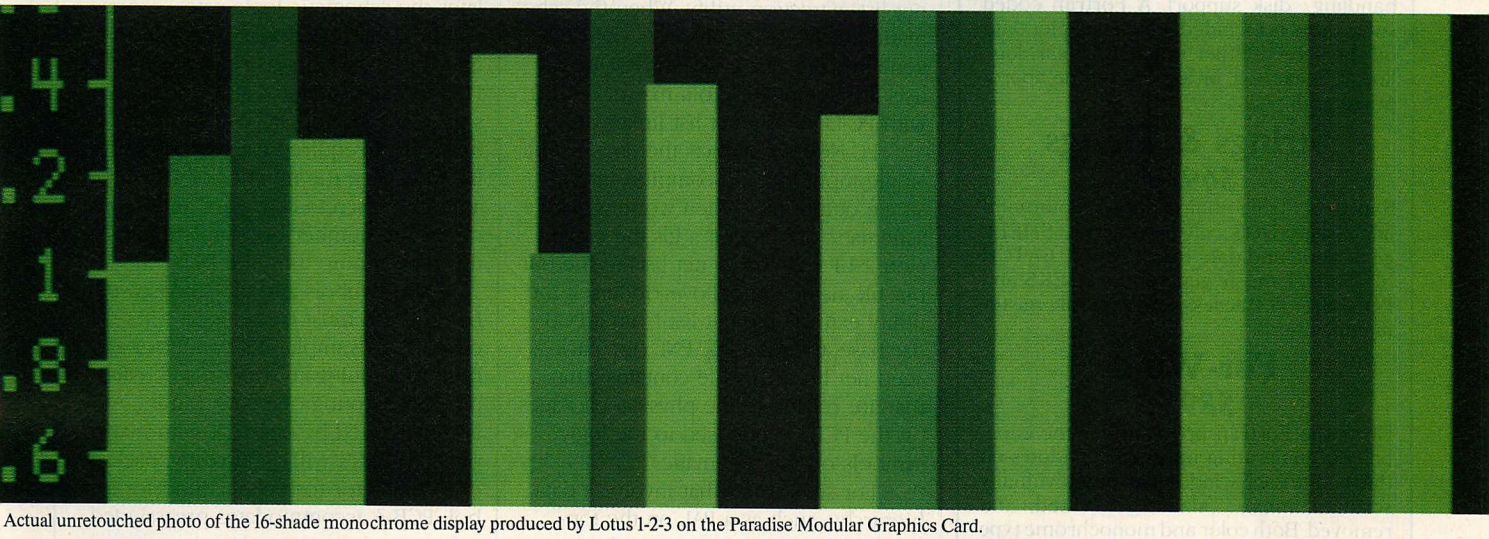
Multiple sheet schematics are anticipated in any CAD system. PCB-3 allows the schematic to be treated and annotated as a single component in SYMB mode through the selection of ATTR/ACOM and entering SHEET=#. The schematic then is ready to link with other sheets. Various optional circuits can be maintained on separate files, each having the same sheet number for this attribute within each set of optional circuits, with one of them linked to other sheets to form a total end design. Then, different sheets also can be substituted at other linkings to produce various schematic designs.

FROM SCHEMATIC TO BOARD

Creating a schematic, however, does not a printed circuit board make. The intel-



Actual unretouched photo of the monochrome display produced by Lotus 1-2-3 on a leading color graphics card.



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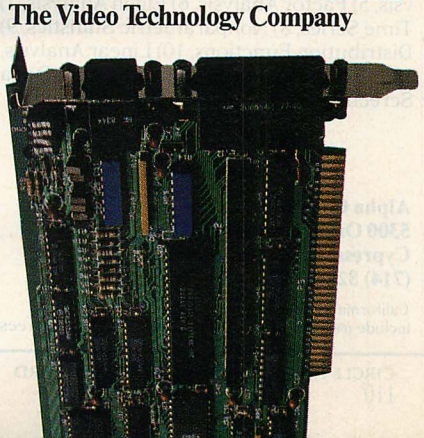

ligence must be extracted and put in order, via PCB-3 modules, to be useful.

The types of errors trapped by the PCB-3 utilities include disk full, file not found, format of file incompatible, insufficient memory space or buffers, file has no nets or pins, loading failures, linking failures, hierarchical expansion failures, batch file syntax errors, damaged or corrupt file data, and interconnecting net failures.

Schematic databases are processed to extract the electronic intelligence as binary net lists using PC-NODES, the net list extraction utility. When the schematic involves several sheets (which is generally the case), the PC-NODES net lists are compiled into a master net list with PC-LINK, the net list linker utility.

PC-NODES extracts the data from a single input file and compiles into a single output file. When working with a schematic database, it adds the extension .NLT (schematic net list) to the output file name, unless overridden. If the utility extracts the net list from a PCB database, then it adds .PNL (for packaged net list). This file contains data that are related to the physical packages on the PCB, as opposed to the logic symbols on the schematic.

For schematics that involve a data hierarchy, such as a PAL on the top-level schematic and its internal schematic on a referenced lower-level schematic, PC-LINK combines the several net lists into one binary net list. This file is given the default .XNL extension.

The PC-NODES or PC-LINK net lists then can be processed by PC-FORM. This report generator creates reports in four list formats—components, nodes, packaging, and wiring—that show the interrelationships of components (schematic logical or PCB physical components) and their nets. PC-FORM also produces a bill of materials report.

The ASCII component library cross-reference file is compiled from a user-prepared ASCII list into a tightly compacted, binary format using PREPACK, the cross-reference library compiler. The ASCII records are stored in a file with the extension .FIL; the binary packaging cross-reference or packaging library generated by PREPACK has been given a file extension of .LIB.

The *short format* is a sequential file with records holding four fields: (number of) #gates, part type, part path\file name, symbol path\file name. The number of gates is always 1 or more. The part type is a user-selected generic description, such as RES for resistor or the device number for a chip. PREPACK allows each symbol or parts library file to contain the directory path name, which is important because numerous subdirectories may be in use for library storage. It is acceptable to package symbols that are different in the schematic into the same part.

PC-PACK is the workhorse in getting from the schematic to the PCB. Here, the logical net lists from PC-NODES for single-sheet schematics or those from PC-LINK for multiple-sheet schematics are examined against the PREPACK compiled library and packaged into PCB databases. PC-PACK translates the schematic logic gates, connector pins, discrete devices, and so on into the physical parts required on the PCB to implement the electronic design. For example, PC-PACK looks at the number of required gates of a particular type, then the number of gates available in a discrete chip part, and determines the number of complete parts of this type required on the PCB.

The symbols and parts processed by PC-PACK must correspond with each other. For example, if a connector is built as a multigate *symbol*, with each pin representing one gate, but the *part* is represented by one gate with many pins, PC-PACK will, incorrectly, package one connector for every connector symbol. PCB-3 accommodates preassigned reference designators, but the system does not lock assignments of gates and pins that normally can be swapped. Care should be taken to ensure that these assignments are not moved in the PCB preparation process.

The packaged parts are placed in an ordered array in a PCB database according to a referenced environmental layer structure file. The database has the transferred net data, which can be displayed as airlines. Airlines show the direct point-to-point connection between pins on the parts transferred from the schematic to the PCB database.

PC-PACK also produces a physical net list, a packaging command file, and an annotated net list. Errors are saved in an ASCII report file that highlights the more common construction and omission errors. This file reports, for example, if no entry is present in the .LIB file to reference a part for an encountered symbol. While in operation, PC-PACK warns of errors before packaging the parts, so the user can abort and correct before continuing.

The physical net list from PC-PACK is identical to the one PC-NODES would extract from the present version of the PCB database. It can be used to generate reports from PC-FORM. The packaging command file, also an output from

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PC-PACK, is an executable macro that can be invoked in PC-CAPS sequentially to load and annotate the schematic to correspond with the packaging of the PCB. This feature is most useful when little or no SCMD/PNUM has been done—the schematic can be annotated quickly to produce the initial representation of the PCB database. The back-annotated net list (.BNL) is a binary file that is identical to what PC-NODES would extract from the schematics after processing them through the packaging command file. The initial version of this file should be retained for back annotation use with PC-BACK after the PCB layout is complete.

PCB design using the PC-CARDS, PC-ROUTE, PC-PLACE, and PC-DRC/NLC utilities will be examined in a subsequent article; however, to conclude the tour of the modules, it is necessary to assume a design has been completed. In designing the board, the user will make pin, gate, and component swaps. Usually he renames some, if not all, components with new reference designators. This process creates a swap report file that must be kept diligently and not overwritten. To complete the documentation loop, the PC-BACK program compares the swap report to the packaging command file and generates a final command file. It also generates an error file, if necessary.

DOCUMENTATION BY PCB-3

The final leg of the first half of this system's operation is documentation production. PC-FORM produces partial support: traditional documentation involves much more—schematic diagrams, PCB fabrication drawings, and PCB assembly drawings, for example. The main editors provide a command facility to write a selected group of data from activated layers to a *plot file*. The data in this file are the same whether they are to be photo plotted, pen plotted, or printed. Yet the data, as coded in the plot file, need to be processed further toward one of these peripherals.

If PC-FORM receives an unpackaged or unannotated net list (.NLT or .XNL) as the primary input file, the syntax used will include the default system assignments of both instance designators and net names.

The Component List report lists each component separately, by device number order, with its reference designator, then its pins by name or number with the net attached at each pin, and, if switched on, a list of the component attributes. The Node List presents each node by name order, with the pin

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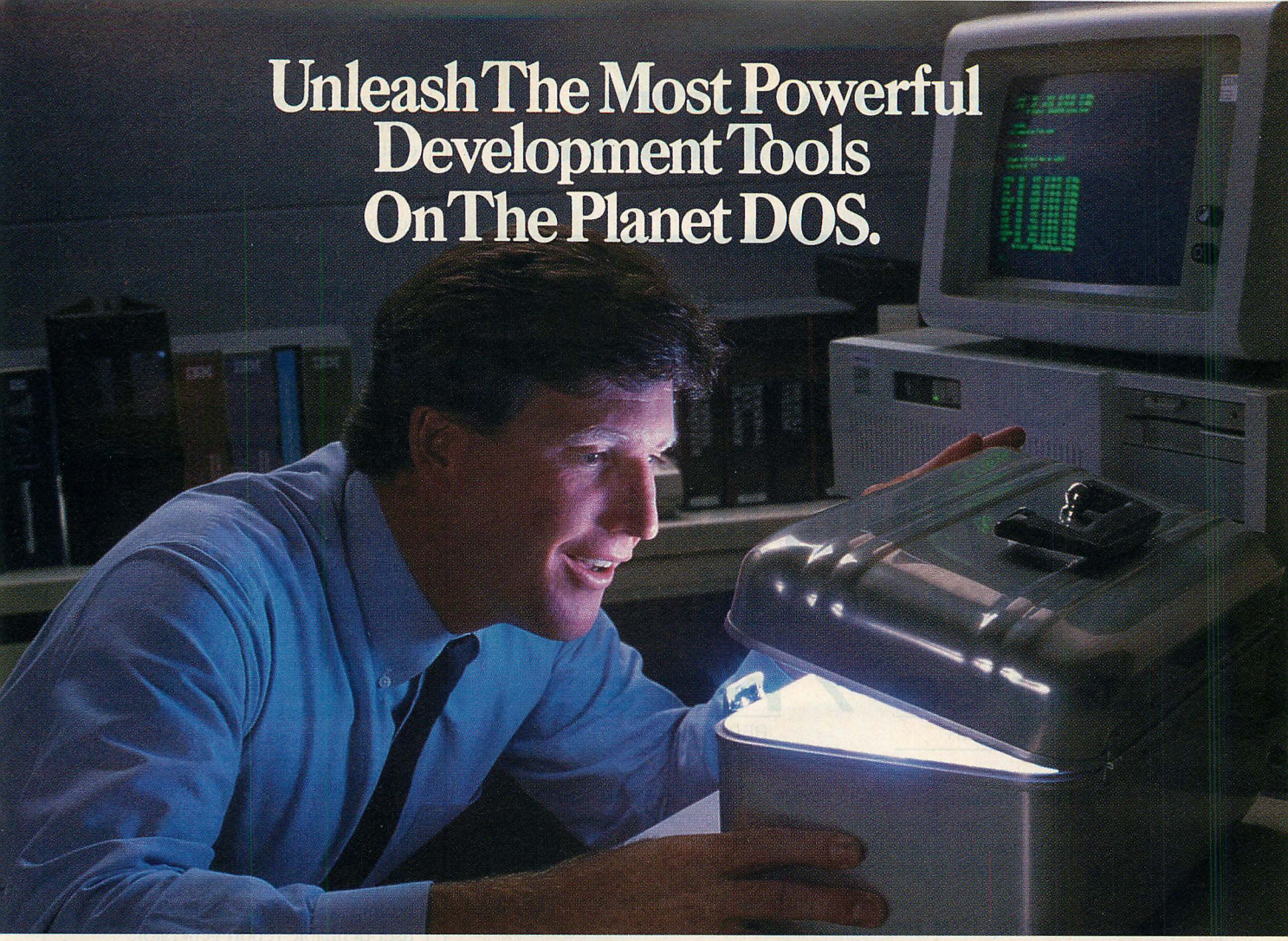

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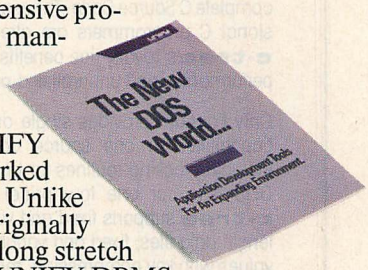

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(name or number), device number (file name of the component), and reference designator connections, as well as path data for hierarchical expansions.

The Packaging List indexes each component by reference designator; the device and instance numbers are not included, but the pins for each component, with the corresponding nets, are. This list allows the selection of attributes to be printed, (as does the Component List). The Wire List presents a traditional node listing format in which each net name is followed with a listing of each reference designator to a pin number connection on the node. This list can be manipulated for export to a CAE system for writing test programs. This report does not provide the coordinates of each pin for automated wire wrapping of prototypes (it is available with P-CAD's simulation package).

Finally, the Materials List is a quantified bill of materials. PC-FORM accepts input from net lists extracted from either schematic or PCB databases. The report produced from schematic net lists displays every symbol by instance; a multigated part, for example, will have a quantity that reflects the number of gates used, not the number of physical devices. This is useful for semi-custom chip designs. The process could be improved by the addition of a user-definable report generator.

Each of the three menu-driven documentation utilities, PC-PRINT, PC-PLOTS, and PC-PHOTO, accepts a plot file as input and processes it into a format for the end peripheral as directed by the user. This output can be saved to disk or used immediately to drive the peripheral. The opening menu for PC-PRINT and PC-PLOTS offers three choices: configuration, operation, or exit. (PC-PHOTO will be discussed in connection with PC-CARDS in the subsequent article.)

Selecting configuration invokes a new menu; the configuration files are generated if the user changes the default values. The selections on this menu include the peripheral model selected, the computer port to which the peripheral is attached, the device type, peripheral or disk file, default paper sizes for printers and pen plotters, and graphics densities for some printers. This menu allows modification of format sizes, text sizes and spacing.

The next menu lets the user specify the input file and make local changes to the configuration for that particular plot and the peripheral to be driven. Each of the operating menus allows the user to see the maximum

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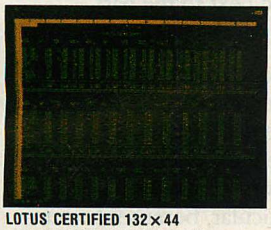

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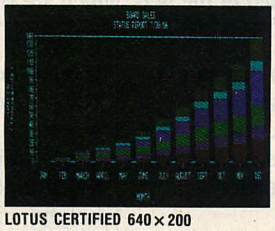

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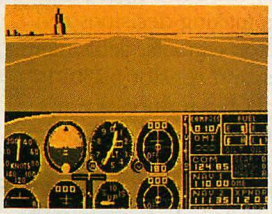

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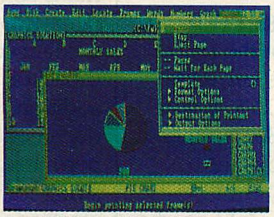

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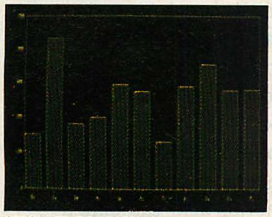

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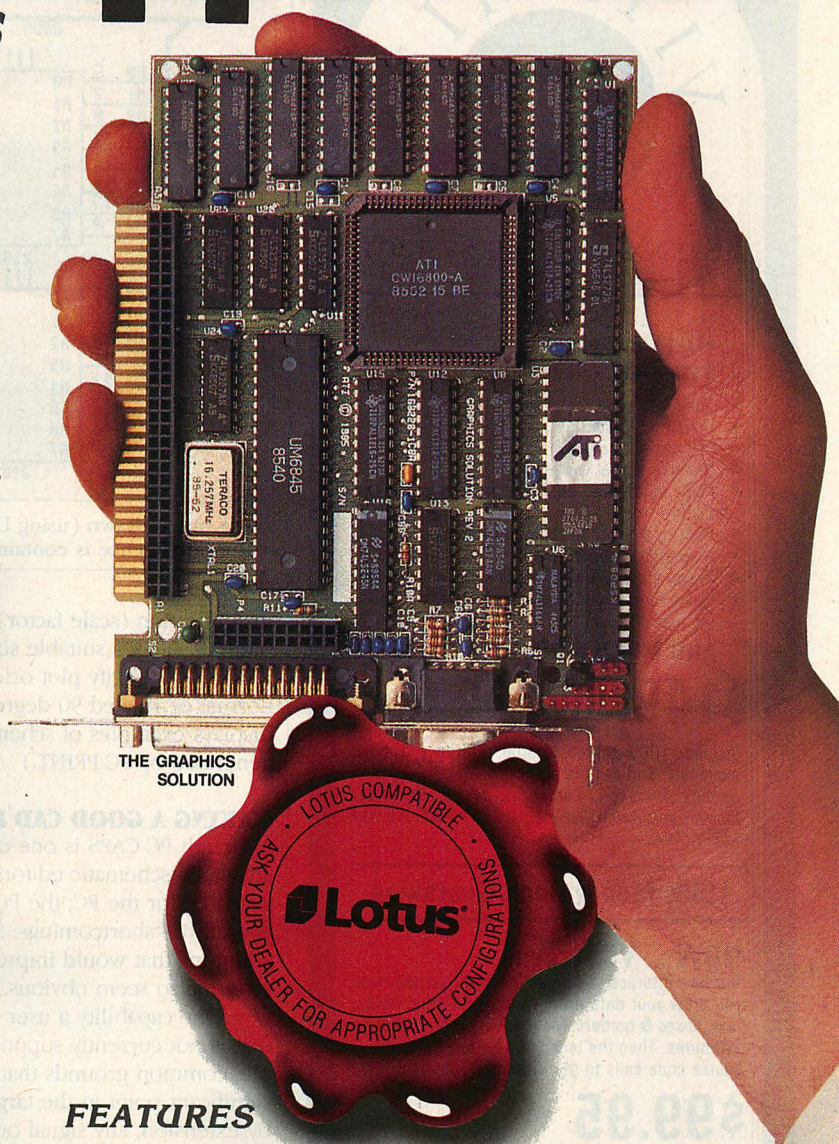

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The Graphics Solution has successfully passed compatibility testing with 1-2-3 (2.0) and Symphony (1.1) on an IBM PC-XT with PC-DOS 3.1. The Graphics Solution must be installed.

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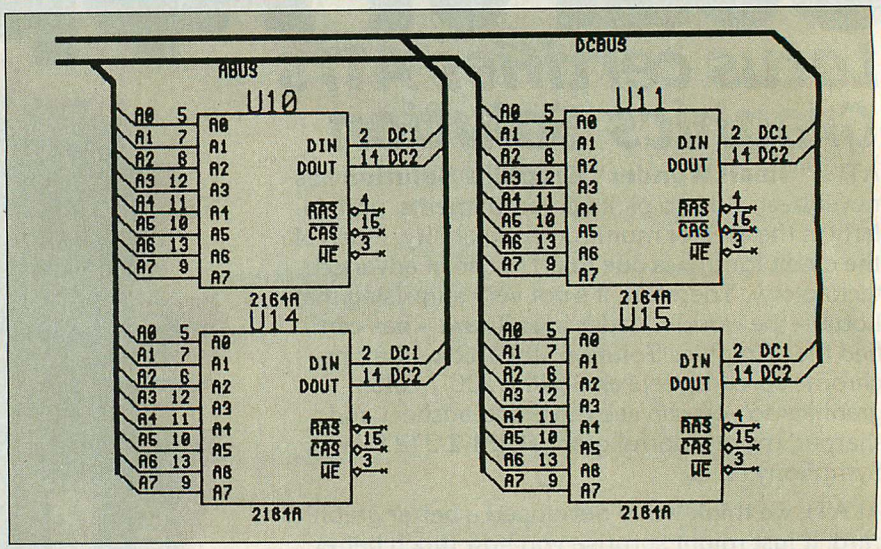
FIGURE 3: *Schematic Examples from PC-PRINT*



The bus is drawn (using DRAW) on the BUS layer and has no electrical significance. The intelligence is contained in the nets, which are situated next to the part.

magnification (scale factor) that can be plotted, select a suitable size in the range, and specify plot orientation, normal or rotated 90 degrees. (Figure 3 displays examples of schematics generated by PC-PRINT.)

MAKING A GOOD CAD BETTER

Although PC-CAPS is one of the more advanced schematic editors currently available for the PC, the PCB-3 system overall has shortcomings. Some other additions that would improve the system also seem obvious.

One capability a user might need that is not currently supported is multiple, common grounds that tie at one significant point in the target PCB. Also, by extension, any signal or potential that has a unique name on the schematic to depict a special, subordinate PCB run of trace for an otherwise unified net is not automatically supported. In this case, notes to the user are necessary in order to make the net-to-subnet connections happen.

The main editor permits the user to push into a symbol, change it, file it, and pop back to the parent schematic, but it has no automated update feature to replace the existing symbol representations in the database. The user must accept the responsibility to delete and replace every symbol in the database and reconnect all the wires.

PC-CAPS also needs a page-referencing scheme to permit carrying signals and other lines between pages and before net extraction and linking. This will solve the problem that arises, for example, when the user names the ground net GND on one sheet and GRD on another; even at linking they would produce two distinct nets.

A quick reference template and function key overlay also would be helpful, in particular, because the tutorial is somewhat terse to be genuinely helpful to users making decisions regarding connector symbols, decoupler capacitor arrays, and resistor packs. In addition, some PCB-3 features are not documented—for example, the feature permitting the typing of a two-letter string for many keyboard command entries instead of the whole mnemonic. The current documentation is, however, an improvement to previous versions. Finally, nets that are global planes in the PCB should have a means for preidentification so that automatic ground planes might be possible.

One prominent criticism of PCB-3 concerns its system speed. Plotting and printing peripherals also can take a great deal of time. This question has no easy answer for users with limited capital. High-speed peripherals are expensive, and for printing, it is the rasterization before print that also is at fault.

The user may bemoan the fact that batch processing is not supported by the utilities. During pen plotting, users need the capability to handle multisheet plots on a continuous sheet plotter, as well as to plot several smaller sizes in an array on a larger sheet size automatically to avoid paper waste. PC-PLOTS offers no such support.

The P-CAD security device, which attaches to a serial port and is required to operate the main editors, also can

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TABLE 5: *Hardware Supported*

MINIMUM HARDWARE REQUIREMENTS
640KB RAM, 10MB hard-disk drive (or shared storage on a network), 360 KB floppy-disk drive, one RS-232 serial port

MACHINES
IBM PC/XT, PC/AT, and compatible hosts
IBM 5550-PC
Tandy 2000
Texas Instruments Professional

GRAPHICS BOARDS AND MONITORS
Conographics model 40 (640 by 400, 16 colors)
Hercules (720 by 348, black and white)
IBM 5550 16-by-16 monitor driver (720 by 480, 16 colors)
IBM 5550 24-by-24 monitor driver (1,024 by 768, 16 colors)
IBM CGA (320 by 200, 4 colors)
IBM EGA (640 by 350, 16 colors)
IBM PGC (640 by 480, 16 colors)
Olivetti EGC, AT&T 6300 display driver (640 by 400, 16 colors and AT&T Color Monitor)
P-CAD HR-25 card and monitor (1,024 by 800, 16 colors)
Tandy TRS-80 high-resolution color board (640 by 400, 8 colors on a Tandy high-resolution color monitor CMI). The Tandy 2000 requires a Tandy graphics card and monitor.
Texas Instruments Professional Color Card and Monitor (720 by 300, 8 colors)
Vectrix PEPE Graphics Card with a supported monitor (1,024 by 1,024, 16 colors). The Vectrix card can support a dual-monitor system, achieved with a primary monitor that has a 1,024-by-1,024 resolution, a 60-Hz noninterlaced, 100 plus-MHz video rate, and a 64-KHz horizontal scan rate, and a separate IBM CGA with compatible monitor.

DIGITIZERS
GTCO Digi-Pad 5
Houston Instruments HIPAD

MICE
Mouse Systems
Logitech
Texas Instruments and equivalents

PRINTERS
C. ITOH 1550, 8510A
Epson MX-80, FX-80, FX-85, FX-100, FX-185, LQ-1500
IBM Proprinter, 5553
Okidata 92, 93
Texas Instruments 850, 855, 860, 865

PLOTTERS
Calcomp 945, 960, 965, 1043, 1075, 1077, PCI Controller
DSCAN GP-5400
Graphtech MP-1000
Hewlett-Packard 7470, 7475, 7580, 7585
Houston Instruments DMP-29, DMP-40, DMP-41, DMP-42, DMP-51, DMP-51 MP, DMP-52, DMP-52 MP
IBM XY/749, 7371, 7372, 7374, 7375
MUTOH 1P-100
Nicolet Zeta 8, 822, 824, 836

PHOTO PLOTTERS
Gerber 32, 33, 41
GTCO FP1-1622, GLASER
Flashscan 4PG2-AAA

The PCB-3 system is supported on many hardware systems and peripherals.

cause problems. The device sometimes blocks the line until the power to the device, a nine-volt DC transformer, is disconnected and then reconnected. This can prevent using the mouse with other software, such as a word processor. Power surge protection is recommended for these devices.

Finally, creating and maintaining new library files may be necessary. The canned libraries available separately from P-CAD cover the majority of common symbols and parts, but they are not all complete or accurate. In some areas the technology may be lacking. P-CAD's digital libraries, for example, do not have power and ground connections on the symbols, although the parts are correct. This is an unfortunate carryover from manual methodology, which relies upon the use of power and ground tables. This creates problems in transferring complete power and ground connection data to a PCB design: these data may have to be added directly in the PCB database.

The innovative and flexible PC-CAPS editor attends to most of a designer's needs. But even with its many lower-level features, it simply cannot answer the larger questions. Nevertheless, this first side of the system, while not perfect or complete by any means, is mature for a PC-based CAD system. (See table 5 for a list of the various hardware and configurations it supports.) The menu-driven operation offers abundant creative opportunity to automate processes further. The on-line error checking is a plus, as is the error trapping during utility processing. The manuals, while improved, still trail the product in thoroughness.

This system goes beyond the simple or enhanced drafting tool sets generally marketed as schematic capture tools. Rather, it is an intelligent, integrated schematic capture facility. The utilities and back annotation features are useful for both schematic and PCB documentation. A user new to the system may produce schematics before long, but using this system to full advantage will take some time.

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Richard Angell is the president of Richard Angell Consultants, a firm specializing in microcomputer CAD applications, operations, and management.

An Execution Profiler for the PC

A custom-made profiler locates time-consuming bottlenecks for developers.

RALPH G. BRICKNER

Application programmers tend to follow the Golden Rule of Optimization: speed up the part of the program that is taking the most time. Many medium- to large-scale computing systems have utilities to provide information about which parts of the program are most heavily used. For example, the UNIX system provides the **profile** command, and IBM mainframes have a "hot-spot analyzer" for programs written in FORTRAN.

This first article in a two-part series introduces techniques for profiling on the IBM PC and presents a simple execution profiler suitable for examining any .EXE or .COM file. Part 2 will review commercial profilers.

The goal for the simple profiler presented here (see listing 2, PRF.ASM, and listing 1, LISTPRF.PAS) is to execute the selected program (.COM or .EXE). At the end of that program, the profiler prints out a histogram showing the relative amount of time the program spent in various address bins (ranges into which memory is partitioned). When the information has been deciphered with linker and assembler/compiler listings, the programmer will know where the program is spending its time.

A profiler, like a debugger, is a program that runs another program under its control. The classic profiler statistically samples the subject code at regular intervals, determining where it is executing at each sample time.

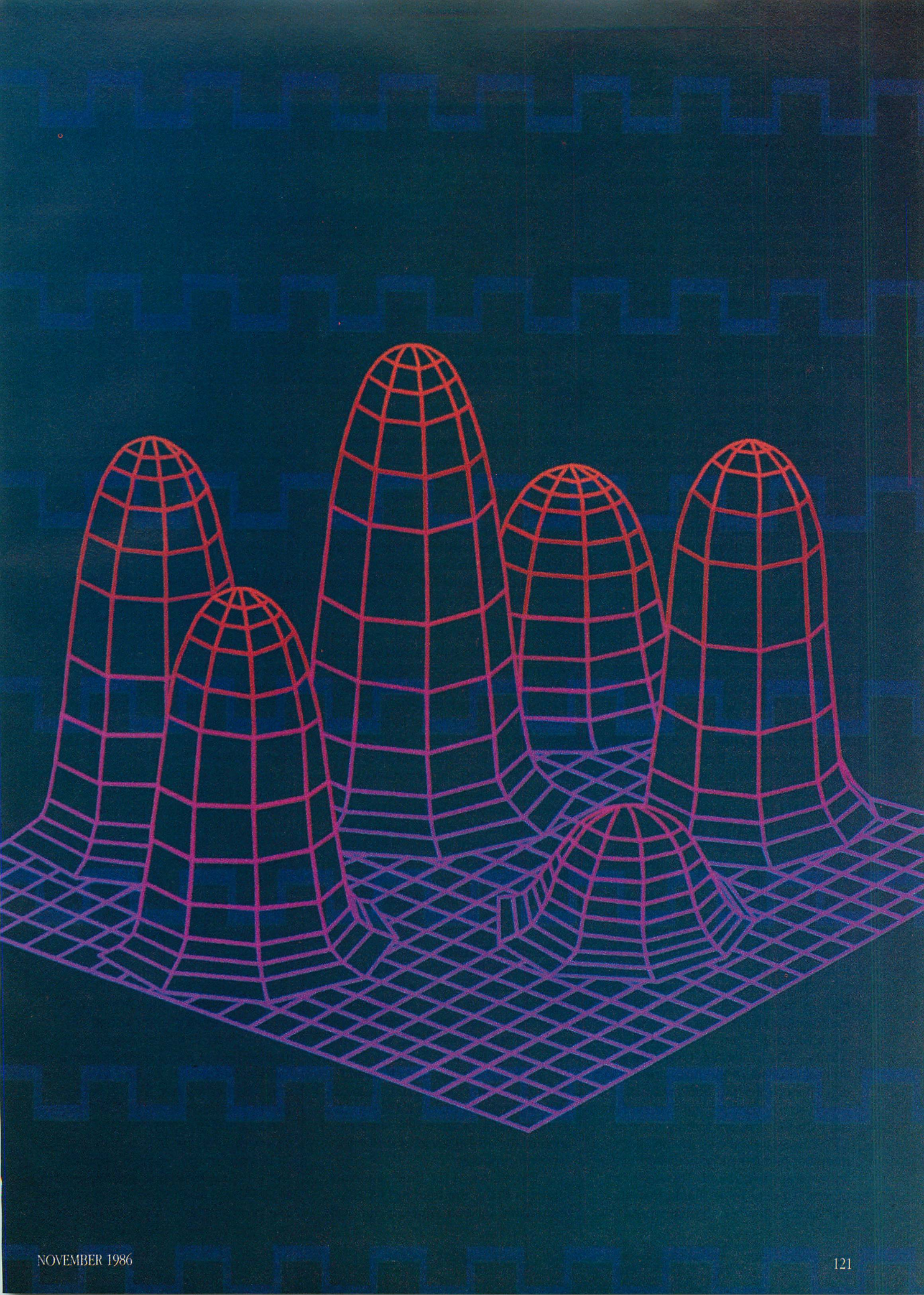
The sampling can be performed using the IBM PC's timer interrupt to look at the address of the instruction the processor is executing when the interrupt occurs. By counting the number of interrupt occurrences in various sections of the code's address space, the programmer can determine where the code spends the most time.

Although the address sampling takes place at a fixed rate, determined by the clock tick, for short programs the rate may be too slow to provide enough addresses for a meaningful analysis. This simple profiler speeds up the clock to provide an acceptable sampling rate. (For a discussion of accurate timing information see, "Life in the Fast Lane," Bob Smith and Tom Puckett, April 1984, p. 62.)

INTERRUPTS

The basic trick of collecting data requires an understanding of interrupts in general and the timer interrupt in particular (see "Interrupts and the IBM PC," Chris Dunford, November/December 1983, p. 173 and January 1984, p. 144). An interrupt takes place when an event causes the microprocessor to interrupt its normal processing. This event may come from a hardware signal (hardware interrupt) or from a software instruction (software interrupt).

An interrupt causes the 8088 to push onto the stack (wherever that may be) the segment, offset, and flags of the



code that was executing at the time. The processor then jumps to an address contained in the very lowest part of memory, where a number of different addresses (known as interrupt vectors) are stored. These interrupt vectors correspond to several different interrupts. The interrupt handler, pointed to by this address must be written to take care of any services required by the hardware or software from which it is invoked. It must end with an IRET instruction, which restores the flag register and jumps to the segment and offset stored on the stack when the interrupt occurred. In addition, the interrupt handler must save all registers (except the flags) so that the code to which it returns will not have its environment altered, with disastrous results.

The register-saving step can be avoided with system software interrupts (DOS and BIOS interrupts), if the manuals are followed carefully. Many BIOS interrupts preserve some registers intact, this behavior is documented in the PC, PC/XT, and PC/AT Technical Reference Manuals. DOS pushes registers itself during a DOS function call interrupt, so the only overwritten registers are AX and others explicitly designated for use by the function (see the *DOS Technical Reference* manual).

Maskable interrupts are handled by a sophisticated chip called the 8259A Programmable Interrupt Controller, which may be programmed to ignore specific types of interrupts, or to change the way the chip prioritizes interrupts for presentation to the 8088 for servicing. The 8088 itself may postpone being interrupted by an interrupt by executing the CLI (clear maskable interrupts) instruction. Interrupts that can be postponed include the keyboard, system timer, and diskette adapter interrupts. An exception is the non-maskable interrupt (NMI), which is used to report memory errors and must gain control of the CPU immediately. An NMI cannot be disabled by the CLI instruction, nor is it managed by the 8259A.

When the 8088 is interrupted, perhaps by the timer, it stores on the stack the location and flags of the code that was executing when the interrupt occurs. (The location is CS:IP, the segment and offset of the instruction pointer.) This enables the IRET instruction to return to where the original code left off, with the flags set as they were.

This system allows the profiler's interrupt handler to be activated when an interrupt is invoked. The stack can be read to determine the address that was executing when the interrupt took

FIGURE 1: *Initial Report*

```
                        Execution Profiler
Location of accumulated address table & length  (all hex):
Seg     = 162E    Ofs     = 0680  Length   = 013D
Code segment for this program is:  25A3
There are 6 distinct CS registers:
     #   1  is  00EC;  there were      132 counts.
     #   2  is  C800;  there were      126 counts.
     #   3  is  0070;  there were       13 counts.
     #   4  is  25A3;  there were        9 counts.
     #   5  is  0747;  there were       21 counts.
     #   6  is  F000;  there were       16 counts.
There were      317 total counts,  spanning        17.42 seconds.
There were      126 counts in Fixed Disk Control  (CS=C800).
There were       16 counts in BIOS  (CS=F000).
```

The profiler shows where the program is spending its time with a "hit count" for each active segment in the 640KB address space. The address of the currently executing instruction is sampled 18.2 times per second, a rate which can be increased.

place. This is exactly the information needed by the continually sampling profiler. The programmer can save these addresses or increment a counter corresponding to some address bin in which the address is located. The profiler's interrupt handler must preserve all but the flag registers while the handler does its own processing. It must jump to the original interrupt handler when finished, so that its necessary functions may be carried out.

Note that it is absolutely necessary to jump with the JMP instruction to the original handler, instead of CALLing it. A CALL would push onto the stack an additional segment and offset that would correspond to the location in the interrupt handler following the CALL. The original interrupt handler does an IRET to return to the interrupted code, which pops the flags in addition to the segment and offset of the calling code. If the profiler's interrupt handler invokes the original handler with JMP (leaving the stack untouched), the IRET in the original interrupt handler will return control to the original program as it is supposed to do.

PERFECT TIMING

The timer in the hardware of the IBM PC generates an interrupt 18.2 times every second. The timer interrupt operates through interrupt vector 8H, which is stored at location 0:0020. Interrupt vector 8H points to a routine located in the BIOS that updates the clock and determines how long to spin diskettes. This dependency makes it risky to modify timer ticks, because disk services require the 18.2 ticks/second rate to function properly.

The source of the timer interrupt, interrupt 8H, is the Intel 8253-5 Programmable Interval Timer, a chip with three separate timers, all driven by a single input from the system clock. These timers can be programmed with a countdown value by sending data to an output port. For example, timer 0 generates interrupt 8H and is programmed during power-up by BIOS to function in mode 3, with a countdown value of 0 (65,536 counts between interrupts), counting down in binary arithmetic. (See the *IBM Technical Reference* BIOS listing, "8253 Timer Checkout.") In operation, the 8253 is driven at the CPU clock frequency of 1.19 MHz (4.77 MHz divided by 4). Timer 0's internal counter is decremented at this frequency (every .84 microseconds), and each time it reaches 0, it is reset and the 8253 generates an interrupt to the interrupt controller chip. This occurs 18.2 times per second—65,536 counts occurring between interrupts. The interrupt controller sends the actual interrupt 8H to the CPU for servicing.

A SIMPLE DESIGN

In this two-part profiler, an assembly language kernel loads and runs the application program, stores collected data in memory, and uses the DOS EXEC function to load and run a Turbo Pascal data reduction program. The first task of the kernel is to release to DOS all the memory that it does not need. Next, the kernel replaces the existing timer interrupt vector with a vector pointing to a portion of itself. The new interrupt handler will do the actual data collection. The kernel then sets up parameters to pass to DOS in the EXEC function call and executes the EXEC function with interrupt 21H, function 4BH. DOS loads in the required program, and it begins executing. During the subject's execution, the kernel is not active. The profiler's timer interrupt handler

intercepts timer interrupts and collects timing data in the profiler's data table until the table size is exceeded. After this, no more data are collected.

When the subject program finishes execution, DOS returns control to the kernel just after the point at which the EXEC function was called. The kernel replaces the timer interrupt vector with the vector to the default handler that was there before the profiler began. Its next task is to run the Turbo Pascal program that outputs the data in a useful fashion. As before, the kernel sets up the necessary parameters for the DOS EXEC function call. In addition, it puts the address of the profiler data table in file control block (FCB) 1 that is to be passed to the output program. The kernel then performs the interrupt 21H, function 4BH. DOS loads in the output program (LISTPRF.COM), which reads the address of the profiler data table saved in its own program segment prefix. Using this address, LISTPRF.COM reads the table and does the necessary formatting and output. When the output program is finished, control once again returns to the profiler kernel, which then uses the standard DOS function call to terminate and release memory.

PROFILER IN ACTION

Suppose a programmer wants to find out where CHKDSK.COM spends its time. The following files must be present in the current directory:

CHKDSK.COM (for this example)
PROFILE.BAT (see below)
PRF.COM (listing 2)
LISTPRF.COM (listing 1)

where PROFILE.BAT has the contents

```
copy %1 subject.com
prf %2 %3
del subject.com
```

PROFILE.BAT simply copies the program to be sampled to the temporary file SUBJECT.COM, then invokes the profiler kernel PRF.COM. It does not matter if the program is a .COM or a .EXE file (see below).

When the user types **profile chkdsk.com c:**, CHKDSK executes, and the profiler displays the summary data (see figure 1). All segments and offsets are given in hexadecimal format. The first information displayed is the address and length of the accumulated data table. The amount of storage allocated to the table by PROFILE is fixed; the length of the actual data accumulated during the run is reported here.

The second number displayed is the code segment for LISTPRF. In the example, it is 25A3H. This is also the segment address for the program segment prefix of the subject code. Subsequent data will report various segment counts from the subject, and this should be one of them (if the subject is a .COM file) or 10H less than one of them (if the subject is a .EXE file, not linked /HIGH).

The next set of data is the number of segment values found corresponding to distinct CS registers, the values of those segments, and the total counts in each segment—in this case, six. Segment 25A3H, the CHKDSK code segment, had nine counts. Listed next is the total number of counts, 317, and the time the subject took to execute.

Why does CHKDSK spend only .5 seconds (9 counts) in its code segment? That question is answered by looking at the other segments. The most "hits" were in segment 00EC (132). This is in low memory, where DOS resides. The next highest count is in segment C800H (126). As listed after the total counts, this corresponds to the ROM used for hard-disk control. Segment F000, which is BIOS ROM, had 6 counts. Finally, a total of 34 counts occurred in two other segments in low memory (Segments 3 and 5 in figure 1). Not surprisingly, CHKDSK appears to spend a lot of time doing DOS requests and in calls to the hard-disk ROM.

The remaining functions of the profiler provide histograms of the segment counts and offsets within the segments. The assumption is that the program will have a small number of code segments whose statistics are needed. Figure 2 is a segment histogram from CHKDSK. This is just a graphical representation of the data from the first screen. The only option is whether or not to send it to a printer.

FIGURE 2: *Segment Histogram*

```
                    Segment Histogram

        0                       .5                      1.0
        |                       |                       |

00EC >  ****************************
C800 >  ***************************
0070 >  ***
25A3 >  **
0747 >  *****
F000 >  ****

There were    6 different segments.
There were  317 total counts
```

This histogram graphically depicts the relative activity in each of the six segments used in CHKDSK. Optionally, it may be printed. The assumption is that the program will have a small number of code segments for which the statistics are needed.

FIGURE 3: *Zooming In*

```
                Offset Histogram for Segment C800

          0                       .5                      1.0
          |                       |                       |

0227+0089 >  *
02B0+0089 >
0339+0089 >
03C2+0089 >
044B+0089 >
04D4+0089 >
055D+0089 >
05E6+0089 >
066F+0089 >
06F8+0089 >  ************************************************************
0781+0089 >  ********

There were  126 counts in this segment, C800
Minimum offset in this segment was 0227
Maximum offset in this segment was 0782
```

The profiler reports activity within a selected segment (segment C800H, in this case). The active area of the segment is split into 11 partitions or "bins", each 89 bytes wide. The hit count is displayed, with each asterisk indicating a hit.

EXECUTION PROFILER

LISTPRF.PAS allows the programmer to zoom in on a single segment of the code with a two-phase zoom capability. First, the number of bins must be specified (less than 2,049). Next, specify whether or not to list the empty bins. To use these options to advantage, use a very small number of bins and display all of them whether full or not. Figure 3 is the result of specifying 10 (decimal) bins for segment C800H in the CHKDSK example. One sample occurred within 87 bytes of offset 227, with the bulk of the counts occurring in the two bins starting at offset 6F8H. LISTPRF.PAS determines the width of the bin as the maximum offset minus the minimum offset, divided by the number of bins (in the example, [782 − 27] / A = 89, with all numbers in hexadecimal). The minimum bin width is 1.

To look at the data more closely, the user could run the offset histogram for C800H, but specify 1,400 (decimal) bins (larger than the number of bytes spanned by the executed code), and answer **n** when asked to display empty bins. The resulting byte-level histogram would show activity at offsets 227 and 737 to 782. The hard-disk BIOS listing in the *IBM Technical Manual*, indicates that the 227 offset is in the bootstrap loader. The remaining samples are in a small piece of code labeled "WAIT FOR INTERRUPT" (offset 737), and procedures PORT_0 and PORT_1. This indicates that CHKDSK spends a lot of time waiting, common with disk accesses.

PROFILE OF A PROFILER

The actual profiler kernel assembly code is provided in PRF.ASM (listing 2). Two user-changeable constants are available at the beginning: the size of the data table in bytes, and the clock speed-up factor. The values as provided give 60KB for the data table and a speed-up factor of 1 (no speed-up). Following the constant declarations is the main procedure, PROFILE. PROFILE first sets up its own stack area, because DOS sets the stack pointer to the end of the code (= stack) segment—that is, at the high end of the 64KB segment from where the code is loaded. That much stack space is not really necessary; the *DOS Technical Reference* recommends 80H bytes to accommodate the interrupt system, in addition to the programmer's needs. In the example, 100H double-words have been allocated.

After resetting the stack, PROFILE calls FREE_MEM to free any unused memory. When the profiler kernel is loaded, DOS allocates the whole remaining memory to it. This includes the portion of memory that is occupied by COMMAND.COM, which should not be written over. (Otherwise DOS will have to reload COMMAND.COM from disk upon completion.) The programmer must determine how much memory is actually needed for the program and data, and return the rest to the system.

Returning unused memory to DOS is a simple matter, accomplished with a DOS function call. The carry flag is set if an error occurs. The programmer then checks for successful completion of the memory release. If it is not successful, an error message is issued and the program is terminated at that point.

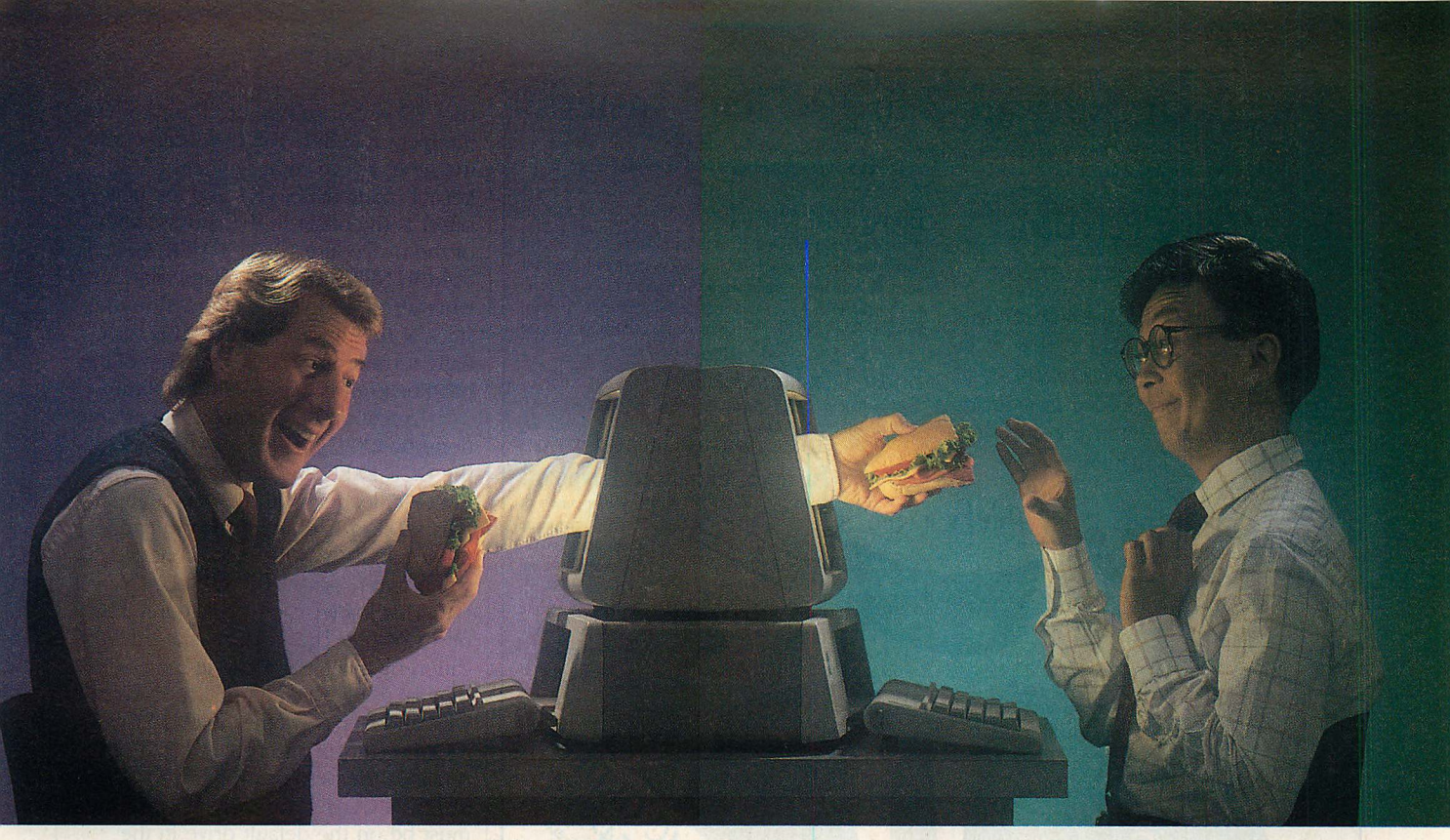
The kernel's next task is optionally to speed up the clock interrupt and replace the existing interrupt 8H with an interrupt vector pointing to its own code. This is accomplished by procedure REPLACE_TIMER.

The software interrupt handler must perform its appointed tasks and then send an end of interrupt (EOI) back to the interrupt controller to enable generation of other interrupts. To speed up the rate at which interrupt 8Hs are generated, and hence the sampling rate, reduce the 8253 interval timer's 0 countdown value, setting it to a constant defined at the beginning of the program. In practice, a speed-up factor is specified (NUMBER_OF_TICKS) that divides the maximum possible countdown value (MAX_TIMER_COUNT). This new value is sent to timer 0.

To ensure that the original interrupt 8H handler is executed at the proper rate, the programmer should skip jumps to it on all but every NUMBER_OF_TICKS interrupt 8Hs. The code in NEW_TIMER accomplishes this reprogramming. In actuality, the countdown value is set to 0 at power-on, so that the timer counts 65,536 input signals before generating an interrupt. Because 0 divided by any speed-up factor is still 0, the maximum countdown value has been set to FFFFH, or 65,535. When the profiler finishes sampling, the timer is reset to the original value of 0.

A word of caution is in order about speeding up the timer interrupt. Because a number of instructions are executed each time the interrupt occurs, the overhead of the sampling process is increased as the frequency of the clock interrupt is increased. At a clock speed-up of 500, almost all of the time is spent in the sampling process.

NEW_TIMER next saves the original interrupt 8H vector from low memory (so that it may be JMPed to) at OLD_INT8, it then sets the new inter-



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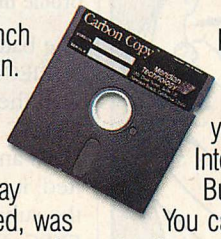

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EXECUTION PROFILER

rupt 8H vector to point to the profiler's interrupt handler. The new segment is the same as the code segment of the kernel (contents of CS), and the new offset is the offset in the code segment of the procedure NEW_TIMER. A flag is used in NEW_TIMER to determine whether to sample the address on the stack at the timer interrupt. This is initially turned off, so that sampling of the profiler itself is kept to a minimum.

Execution of the subject program is done by EXEC_SUBJECT, which uses the DOS EXEC function call to invoke the DOS loader. With this call, the user tells DOS to load in a program and let it execute. DOS will return control when that program is finished.

This loader can load either a .EXE or .COM file. The loader makes identification by means of a flag in the beginning of the file. Attempting to load a file with an extension other than .EXE or .COM results in an error. A batch file renames the desired program to SUBJECT.COM. (For simplicity, this file must be on the default drive in the current directory.)

This implementation passes on the parameters typed in on the batch file execution line to the profiler program, which in turn passes on the parameters to the subject program. For example, to profile the program MYPROG.EXE, passing it the files F1.DAT and F2.DAT as parameters, the command line is:

```
profile myprog.exe f1.dat f2.dat
```

The batch file copies MYPROG.EXE to SUBJECT.COM, then executes PRF.COM with the parameters F1.DAT and F2.DAT. PRF.COM then passes on the FCBs and command line that it inherited; it transfers them from PRF's PSP to the subject program's PSP in the EXEC_SUBJECT subroutine. The result is that MYPROG.EXE sees F1.DAT in the first FCB, and F2.DAT in the second, while the command line at its PSP 80 is

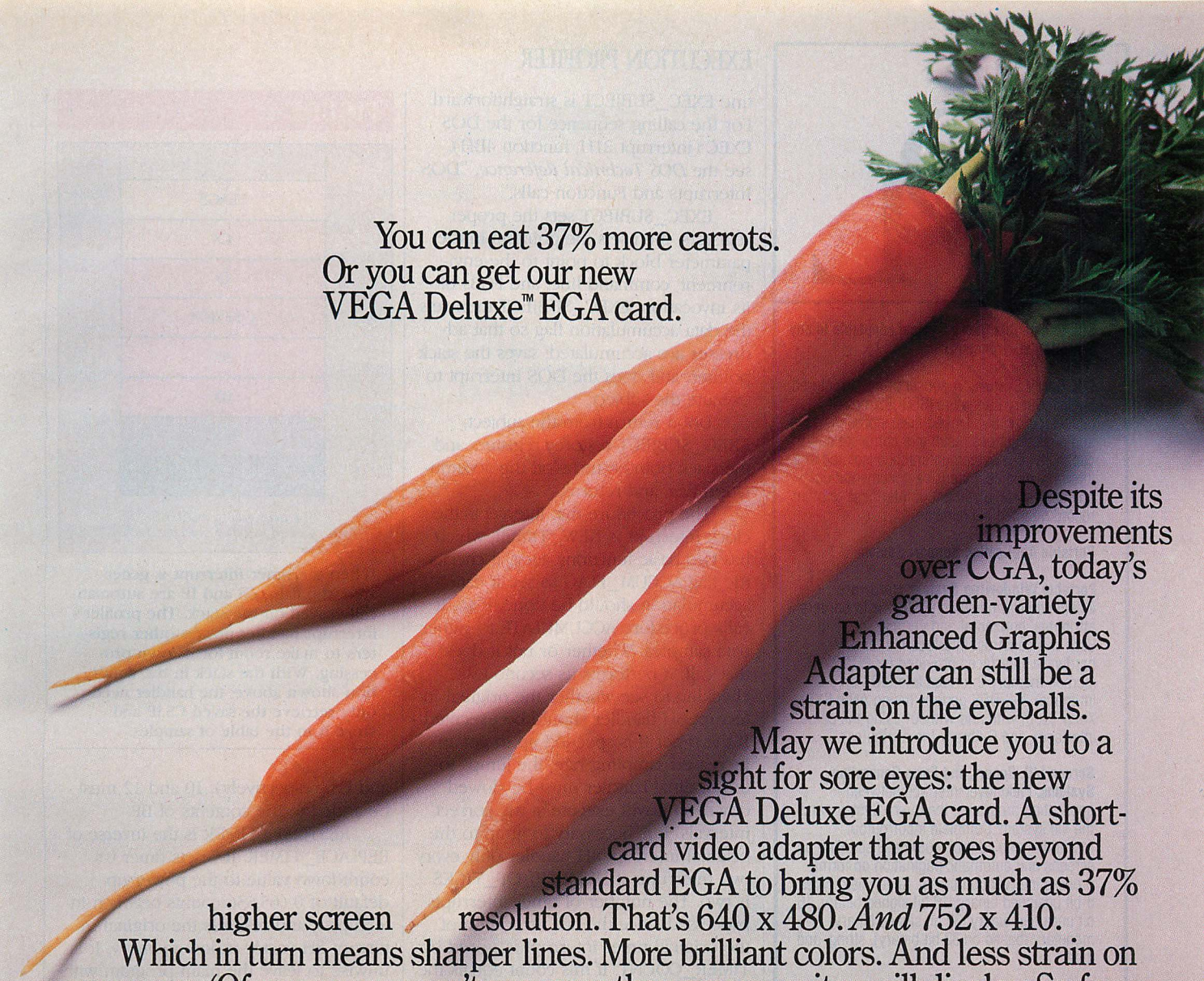
```
f1.dat f2.dat
```

The assembled and linked profiler kernel is called PRF.COM. To continue with the example above, type

```
profile myprog.exe f1.dat f2.dat.
```

When MYPROG.EXE executes, it is given the parameters that are passed to PRF.COM on the command line. A commercial profiler executes without copying the code to another file. It reads its own command line at PSP location 80H and shifts the parameters by one, passing on the proper parameters to the program.

The actual coding of the subrou-



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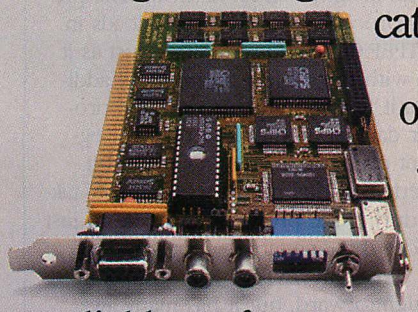

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tine EXEC_SUBJECT is straightforward. For the calling sequence for the DOS EXEC (interrupt 21H, function 4BH), see the *DOS Technical Reference*, "DOS Interrupts and Function calls."

EXEC_SUBJECT sets the proper registers, then sets the pointers in the parameter block to point to the environment, command line, and FCBs of its invocation. EXEC_SUBJECT then sets the data accumulation flag so that addresses are accumulated, saves the stack pointer, and does the DOS interrupt to execute the subject.

Upon return from the subject, EXEC_SUBJECT restores registers and the stack pointer, turns off the accumulation flag, and returns.

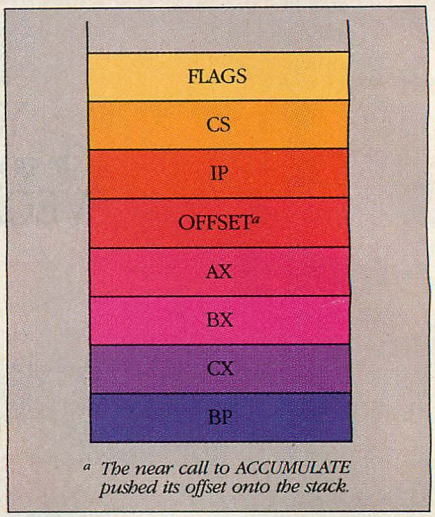
The procedure that intercepts the clock interrupt is NEW_TIMER, which has two basic functions. First, it checks the flag ACCUM_FLAG to see if data accumulation should be done. If so, it calls procedure ACCUMULATE to gather data samples. Whether or not it does that call, it performs its second task, checking to see whether the original interrupt 8H handler should be executed. If the timer 0 is speeded up to get an increased sampling rate, the jumps to the original handler must be slowed down, so it will execute at the correct intervals. It is necessary to jump to the original interrupt 8H handler only every two interrupts if NUMBER_OF_TICKS is two. The number of timer interrupts processed since the last invocation of the original timer interrupt is stored by TIMER_COUNT. If this count equals the speedup factor, TIMER_COUNT is reset to 0, and the original handler is executed with

```
JMP CS:DWORD PTR OLD_INT8
```

OLD_INT8 is the location of the old interrupt stored earlier. If the count is not equal to the speed-up factor, the program sends an EOI to the 8259 interrupt controller, then does an IRET back to the subject code.

ACCUMULATE looks to see if the table is filled up. If so, it returns. If not, it sets BP to SP, and looks on the stack to find the offset (at SS:[BP+10]) and segment (at SS:[BP+12]) of the interrupted code. These are stored in the table (ADD_TABLE), and the table index is incremented. The following stack-modifying instructions were executed: INT8 (actually generated by hardware); CALL ACCUMULATE (done by NEW_TIMER); and PUSH AX, PUSH BX, PUSH CX, and PUSH BP (all done by ACCUMULATE. As a result, the stack contains the two-byte entries shown in figure 4. To get offset and segment (IP and CS, respectively), 10 and 12 must be added to the contents of BP.

FIGURE 4: *Taking a Sample*



[a] *The near call to ACCUMULATE pushed its offset onto the stack.*

When the timer interrupt is generated, the flags, CS and IP are automatically saved on the stack. The profiler's interrupt handler pushes other registers to make room for its own processing. With the stack in the condition shown above, the handler need only retrieve the saved CS:IP and store it in the table of samples.

RESTORE_TIMER is the inverse of REPLACE_TIMER. It resets timer 0's countdown value to the power up default of 0 (65,536 counts between interrupts), and restores the original interrupt 8H vector in low memory. It is unwise to leave the main program without doing this, because the code pointed to by the special interrupt would be overlaid by the next program loaded, with probable fatal results.

Data display is done by a Turbo Pascal program, LISTPRF.COM. The profiler procedure EXEC_PRINT loads in LISTPRF.COM and executes it just as it did with the subject program. In addition, it inserts the address of the profiler data table into the program segment prefix of LISTPRF.COM, and it inserts the total number of samples taken during the profile into the word just before the data table.

Program LISTPRF.PAS (listing 1) is straightforward, but it has many awkward coding details in the histogram procedures. Two points should be noted about LISTPRF.PAS. Turbo Pascal provides access to the CS and DS registers, and it allows absolute memory references. These features are used to find the address of the data table; the segment of the table was stored by PROFILE at offset 5C in the program segment prefix, and the table offset was

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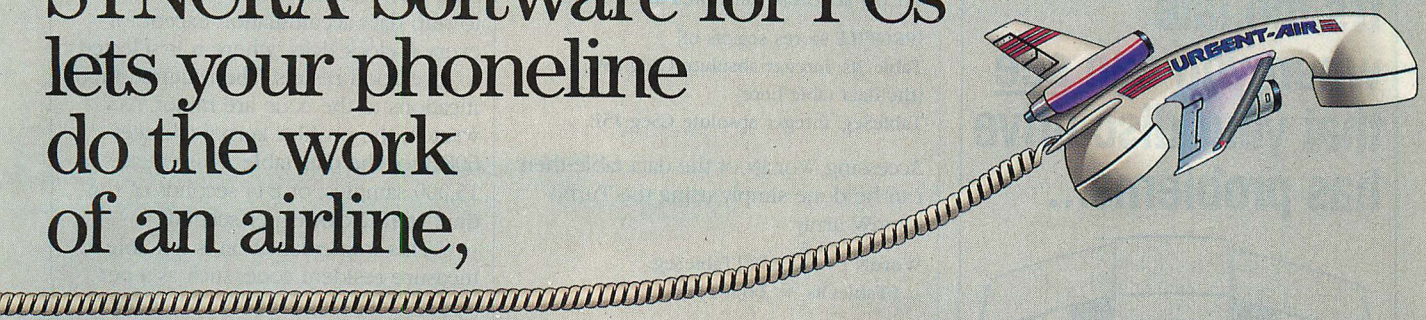

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stored at offset 5E. The corresponding Turbo absolute variables are defined

```
{PROFILE stores seg:ofs of}
TableOfs: integer absolute CSeg:$5C;
{the data table here}
TableSeg: integer absolute CSeg:$5E;
```

Accessing WordN of the data table then can be done simply using the Turbo MemW array:

```
WordN := MemW [TableSeg:
  (TableOfs + 2*(n-1))];
```

LISTPRF.PAS uses these features to do all its data reduction.

IMPROVING THE PROFILER

As mentioned above, the profiler explained here is simple, and programmers are encouraged to extend it. Symbol support would be a useful addition, but the implementation is difficult. The symbol table information is either completely absent (as with Turbo Pascal or other commercial application software), spread about in various places, or different for various language processors. For example, by specifying **pgm.map/map/line** as the third file argument to LINK, the DOS linker will place three types of information in the file PGM.MAP: the addresses of all segments linked; the segment and offset of all PUBLIC symbols, by name and by address; the segment and offset of all line numbers in the source file. (All segment addresses are relative to the beginning of the load module.)

The assembler used to write PRF.ASM, IBM assembler version 1.0, does not provide line number information to the linker; other language processors may or may not generate line number information. PUBLIC name statements for any assembler PROCs or labels must be inserted to show up in the listing. Some language processors (for example, standard DeSmet C) may use a nonstandard link file that DOS LINK cannot process.

A complication comes from the /HIGH parameter to the linker. While it is fairly easy to determine the absolute address of a load module linked without the /HIGH parameter (it goes at the end of the PSP), the loader will put the load module in high system memory if the program is linked with /HIGH.

Another useful extension concerns the sampling rate. As explained above, a facility to accelerate the timer and examine short programs is already in place. However, a problem that might be encountered for long running programs is just the opposite—a sampling rate that is too fast to sample the entire code with any sort of reasonable data base size. A solution to this problem is to skip data accumulation except for every n clock ticks, where n is selected to give good results. The required modifications to the code are minor. As written, the profiler kernel allocates 60KB for the data table. This equates to 15,000 samples, or 844 seconds of runtime at 18.2 clocks per second.

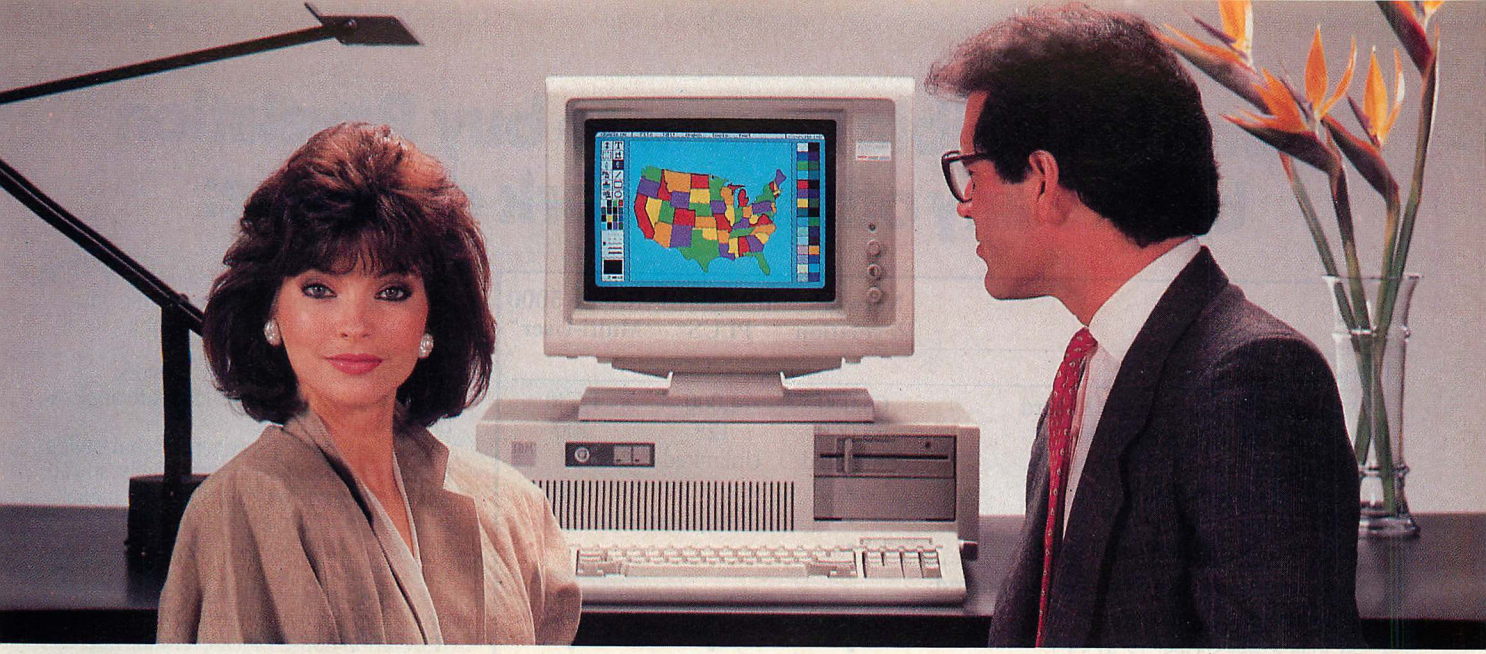
This implementation is not able to measure resident code, such as a permanent interrupt handler. While the profiler takes samples as the resident code executes its set-up portion, the DOS terminate-but-stay-resident function call results in control being returned to the profiler kernel, and the output program is then run. The point of measuring resident code is not to see how fast it sets itself up, but how it runs once it is installed.

The subject code of this profiler is not able to turn sampling on and off. This feature, in fact, is relatively easy to add, because the profiler already checks a flag (ACCUM_FLAG) to see if it should accumulate data or not. To implement turning sampling on and off, both the kernel and the subject program must agree on a location for the flag, so that the subject may set it and the kernel may read it.

For a general program, it is not possible to predict a priori where the subroutines that do the switching of the flag will be loaded, so relative addressing schemes seem problematic. A relatively safe place to store the flag, however, is in the data area used by the BASIC interpreter at location 0000:0218. (See the *IBM Technical Reference* manual for memory maps.) While the BASIC interpreter can be profiled, very little useful information is obtained, and it may therefore be assumed that this memory location is available to use.

Though simple, the profiler presented here has all the essential features; it reports the time behavior of any .COM or .EXE program with "hit counts" and histograms. The sampling rate can be accelerated, and the user can select the range of sampling, zooming in on a segment after reviewing time behavior in the full 640KB address space. Though the user must decipher the hexidecimal addresses, this profiler is still a useful addition to many a programmer's toolbox.

Ralph G. Brickner, Ph.D., is a researcher in parallel processing at Los Alamos National Laboratories, where he also performs benchmark tests on scientific computers.



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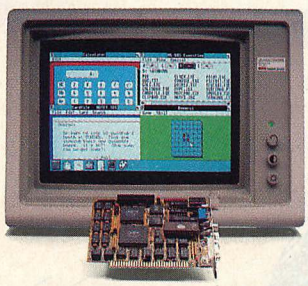

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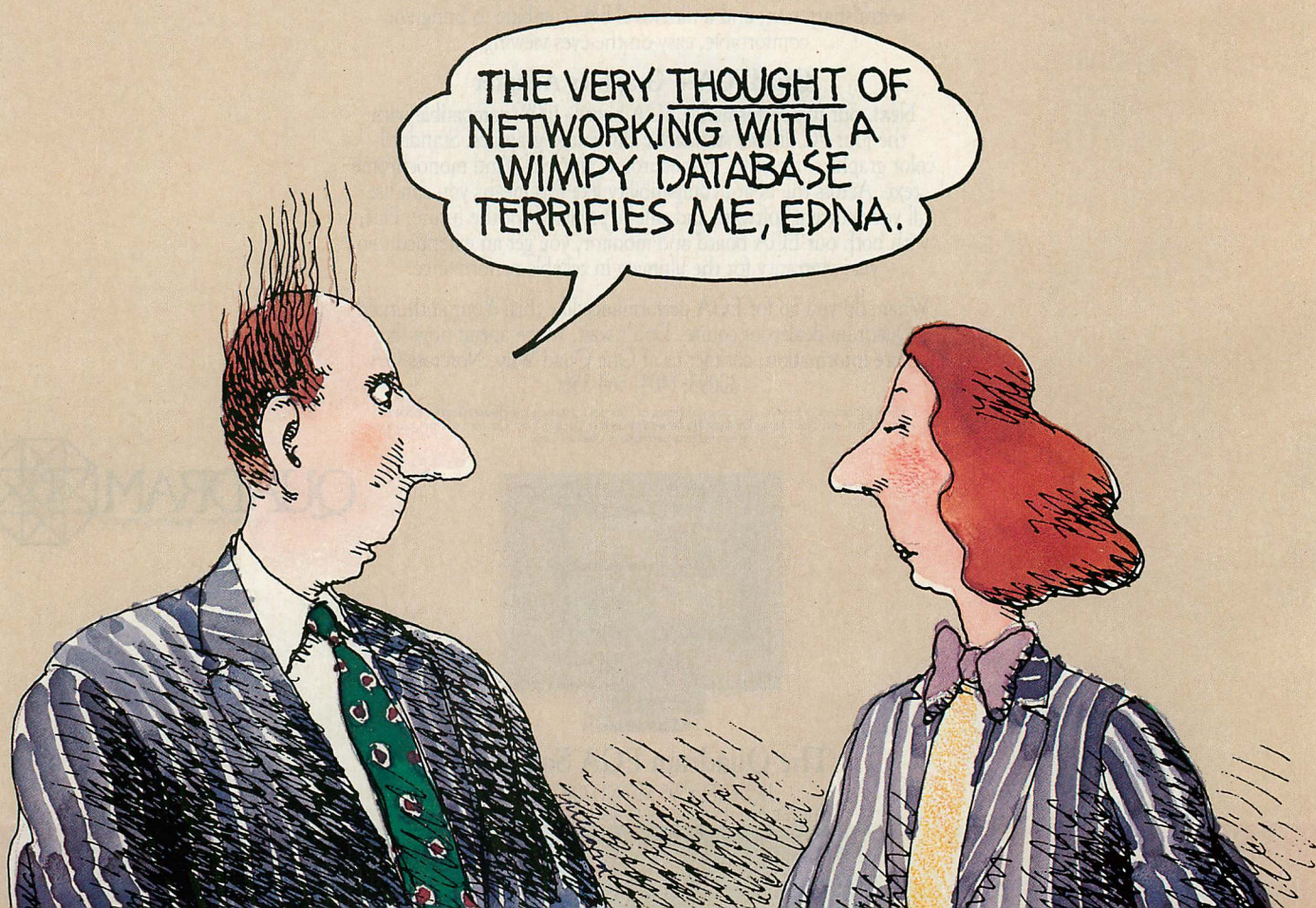

LISTING 1: LISTPRF.PAS

```
program PrintAddresses;

{ Prints address information saved by PROFILE }
{ DEFINITIONS: }

  const
    MaxSeg = 200;          {Maximum number of different segments}
    nul    = '';           {Null character string}
  type
    MaxString = string[255];    {Generic big string}
    string4 = string[4];        {String of length 4}
  var
    bins:     array[0..2048] of real;      {Allow 2048 address bins}
    TableOfs: integer absolute CSeg:$5C;   {PROFILE stores seg:ofs of}
    TableSeg: integer absolute CSeg:$5E;   {the data table here}
    SampSeg:  integer;             {Segment of a sample in table}
    SampOfs:  integer;             {Offset of a sample in table}
    NSampls:  integer;             {No. of samples in table}
    NSeg:     integer;             {No. of different segments}
    NBIOS:    integer;             {No. of hist in BIOS}
    NFD:      integer;             {No. of hits in Fixed Disk ROM}
    i,j,k,n:  integer;             {Global Integer counters}
    SegArray: array [1..MaxSeg,1..2] of integer;
              { SegArray[i,1] = value of ith segment
                SegArray[i,2] = # occurrences of ith segment }
    DoPrint:  boolean;                     {Logical print flag}

{$V-} {Disable type checking of character arguments.}

  procedure print (instring: MaxString);
{ writes to printer if DoPrint true, otherwise to screen }
  begin
                        write   (     instring);
    if (DoPrint) then write   (LST, instring);
  end;
  procedure println (instring: MaxString);
{ same as print, but writes line feed too }
  begin
                        writeln (     instring);
    if (DoPrint) then writeln (LST, instring);
  end;
  function Hex (HexInt: integer): string4;
{ Converts an integer into a four character hexadecimal string }
  const
    HexCh: array[0..15] of char = '0123456789ABCDEF';
  var
    HexHi, HexLo: integer;
  begin;
    HexHi := Hi(HexInt);
    HexLo := Lo(HexInt);
    Hex := HexCh [HexHi div 16] +
           HexCh [HexHi - 16*(HexHi div 16)] +
           HexCh [HexLo div 16] +
           HexCh [HexLo - 16*(HexLo div 16)];
  end;
  procedure AddSeg (Segval: integer);
  var
    oldseg: boolean;
{ increments the tally of hits on a segment in segment array
  or adds a segment to the segment array}
  begin
    oldseg := false;
    for i := 1 to NSeg do
    begin
      if (Segval = SegArray[i,1]) then
      begin
        oldseg := true;
        SegArray[i,2] := SegArray[i,2] + 1;
      end;
    end;
    if (oldseg = false) then
      if (NSeg < MaxSeg) then
      begin
        NSeg :=  NSeg + 1;
        SegArray [NSeg,1] := Segval;
        SegArray [NSeg,2] := 1;
      end;
```

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CIRCLE NO. 182 ON READER SERVICE CARD

```
    end;
    procedure Loop;
  { Loop over hits, doing accumulations and conversions }
    begin
      NSeg  := 0;
      NFD   := 0;
      NBIOS := 0;
      NSampls := MemW [TableSeg:(TableOfs-2)];
  { PROFILE stuffs number of samples before beginning of table here }
      n := 0;
      for i := 1 to NSampls do    { Loop over the number of samples }
      begin
       SampSeg := MemW [TableSeg:(TableOfs + n + 2)]; { get segment }
      { update the list of segments - count ROM hits - increment index
        into table. }
        AddSeg (SampSeg);
        if (SampSeg = $F000) then NBIOS := NBIOS + 1;
        if (SampSeg = $C800) then NFD   := NFD  + 1;
        n := n + 4;
      end;
    end;                          { End loop over the number of samples }
    procedure PrintTotals;
  { Output first screen of total tallies }
    begin
      ClrScr;      gotoxy (31,1);    writeln ('Execution Profiler');
      writeln;
 writeln('Location of accumulated address table & length (all hex):');
 writeln('Seg      = ', Hex(TableSeg), '  Ofs      = ',
                          Hex(TableOfs),'  Length = ', Hex(NSampls));
 writeln;
 Writeln ('Code segment for this program is: ', Hex(CSeg));   writeln;
 writeln ('There are ', NSeg, ' distinct CS registers:');     writeln;
      for i := 1 to NSeg do
        writeln ('# ', i:4, ' is ', Hex (SegArray[i,1]),
                 '; there were ', SegArray[i,2]:6 , ' counts.');
      writeln;
      writeln ('There were ', NSampls:6, ' total counts, spanning ',
                                  (NSampls/18.2):10:2, ' seconds.');
      {NOTE: seconds printout assumes clock not speeded up }
      writeln;
 writeln ('There were ', NFD:6,  ' counts in Fixed Disk Control ',
               '(CS=C800).');
      writeln;
      writeln ('There were ', NBIOS:6, ' counts in BIOS (CS=F000).');
      writeln;  writeln;  writeln('Press return to continue...');
      readln;
    end;
    procedure SegHist;
  { prints out a segment histogram }
    var
      maxcount:  integer;
      ans:       char;
      xn, xs:    real;
      NDots:     integer;
      nstrng:    MaxString;
    begin
      ClrScr;      gotoxy(30,1);      write ('Segment Histogram');
      gotoxy(1,5);
      write('Do you want to print the histogram (y/n)? ');
      readln (ans);      DoPrint := false;
      if ((ans = 'y') or (ans = 'Y')) then DoPrint := true;
      ClrScr;      gotoxy(30,1);      println ('Segment Histogram');
      xn := NSampls;
      println (nul);
      print ( '        0');
      print ( '                                    .5');
      print ( '                                   1.0');
      print ( '    |');
      print ( '                                    |');
      print ( '                                    |');
      println (nul);      println (nul);
      for i := 1 to NSeg do
      begin
        xs := SegArray [i,2];
        bins [i] := xs / xn;
        print (Hex (SegArray[i,1]) + ' >   ');
        NDots := round (70.*bins [i]);
        for j := 1 to NDots do print ('*');
```

```
        println (nul);
      end;
      println (nul);
      Str (NSeg:4, nstrng);
      println ('There were ' + nstrng + ' different segments.');
      Str (NSampls:4, nstrng);
      println ('There were ' + nstrng + ' total counts');
      writeln;  writeln ('Press return to continue...');   readln;
    end;
    procedure OfsHist;          { prints out an offset histogram }
    label  EndOfsHist;
    var
      maxcount, NDots, iseg, iwidth, nbins, ncounts:  integer;
      index, offset, segment, minofs, maxofs, ofslabel: integer;
      ans:       char;
      xn, xs:    real;
      nstrng:    MaxString;
      ListAll:   boolean;
    begin
      repeat
      minofs := $ffff;      maxofs := 0;
      ClrScr;
      gotoxy(30,1);      write ('Offset Histogram');
      gotoxy(1,5);
write('Enter the number of the segment you want (0 to end): ');
      readln (iseg);
      if (iseg = 0) then goto EndOfsHist;
      nbins := 10;
      gotoxy(1,6);
      write('Enter the number of bins desired (< = 2048): ');
      readln (nbins);
      write('Do you want to print the histogram (y/n)? ');
      readln (ans);
      DoPrint := false;
      if ((ans = 'y') or (ans = 'Y')) then DoPrint := true;
      write('Do you want to display empty bins (y/n)? ');
      readln (ans);
      ListAll := false;
```

```
      if ((ans = 'y') or (ans = 'Y')) then ListAll := true;
      ClrScr;      gotoxy(24,1);
      println ('Offset Histogram for Segment '
                                    + Hex (SegArray[iseg,1]));
      println (nul);      print (                ');
      print ( '0                              .5');
      print ( '                              1.0');
      println (nul);      print ( '              ');
      print ( '|                              |');
      print ( '                               |');
      println (nul);      println (nul);
      for i := 0 to nbins        { zero out count array and scalars }
            do bins [i] := 0;
      ncounts := 0;
      n := 0;                    { find max and min offsets (/2) }
      for i := 1 to NSampls do
      begin
        SampSeg := MemW [TableSeg:(TableOfs + n + 2)];
        SampOfs := MemW [TableSeg:(TableOfs + n    )];
        n := n + 4;
        if (SampSeg = SegArray[iseg,1]) then
        begin
          if ( Hex (SampOfs) > Hex (maxofs) ) then maxofs := SampOfs;
          if ( Hex (Sampofs) < Hex (minofs) ) then minofs := SampOfs;
        end;
      end;
      iwidth := (maxofs - minofs) div nbins;     { words per bin }
      if (iwidth = 0) then iwidth := 1;
      n := 0;                    { accumulate counts in the bins }
      for i := 1 to NSampls do
      begin
        SampSeg := MemW [TableSeg:(TableOfs + n + 2)];
        SampOfs := MemW [TableSeg:(TableOfs + n    )];
        n := n + 4;
        if (SampSeg = SegArray[iseg,1]) then
        begin
```

```
          ncounts := ncounts + 1;
          index := (SampOfs - minofs) div iwidth;
          bins [index] := bins [index] + 1.;
        end;
      end;
      ofslabel := minofs;              { print the histogram }
      if (ncounts > 0) then
      begin
        for i := 0 to nbins do
        begin
          if ( (bins[i] > 0) or (ListAll) ) then
          begin
            print (Hex (ofslabel) + '+' +
                   Hex (iwidth) + ' >   ');
            NDots := round (65.*(bins [i] / ncounts));
            if ( (NDots = 0) and (bins [i] <> 0) ) then NDots := 1;
            for j := 1 to NDots do print ('*');
            println (nul);
          end;
          ofslabel := ofslabel + iwidth;
        end;
      end;
      println (nul);
      Str (ncounts:4, nstrng);          { print final statistics }
      println ('There were ' + nstrng + ' counts in this segment, ' +
               Hex (SegArray[iseg,1]));
      println ('Minimum offset in this segment was ' + Hex (minofs));
      println ('Maximum offset in this segment was ' + Hex (maxofs));
      writeln;      writeln ('Press return to continue...');
      readln;
      until (false);
EndOfsHist:
    end;

{ MAIN: }
    begin;
    Loop;              { Initial loop over samples }
    PrintTotals;       { Print total hits, segments, etc. }
    SegHist;           { Print Segment Histogram }
    OfsHist;           { Print Offset Histograms for selected segments }
  end.
```

LISTING 2: PRF.ASM

```
;USER-CHANGEABLE CONSTANTS

;NUMBER OF BYTES IN DATA TABLE (F000 = 60K)
  Table_Size            EQU     0F000H
;NUMBER OF TICKS BETWEEN JUMPS TO ORIGINAL CLOCK INTERRUPT HANDLER
; . = CLOCK SPEEUP FACTOR
  Number_Of_Ticks       EQU     1

;OTHER CONSTANTS

;MAXIMUM VALUE OF COUNTDOWN FOR TIMER 0 INTERRUPT
  Max_Timer_Count       EQU     0FFFFH
;NEW VALUE OF COUNTDOWN FOR TIMER 0 INTERRUPT
  New_Timer_Count       EQU     Max_Timer_Count / Number_Of_Ticks

PSP             SEGMENT PUBLIC
                ASSUME  CS:PSP, DS:PSP, ES:PSP, SS:PSP
                ORG     100H                    ;COM FILE!
;-------------------------------------------------------------
;  profiler kernel                                            ;
;                                                             ;
; tricks:                                                     ;
;     1. program executes file 'subject.com' - which may be   ;
;        a com or exe file.  use a batch file to copy subject ;
;        file to 'subject.com'.                               ;
;     2. run with 'prf fn1 fn2', where 'fn1' and 'fn2'        ;
;        are the parameters you would have typed if you had been ;
;        running the subject code itself.  this allows        ;
;        copying the formatted file info from the profiler's  ;
;        psp into the psp for the subject code.               ;
;-------------------------------------------------------------;
```

EXECUTION PROFILER

```
PRF             PROC    FAR
                MOV     SP, OFFSET END_STACK    ; set top of stack to
                                                ; internal area
                CALL    FREE_MEM                ; free unused memory
                CALL    REPLACE_TIMER   ; replace timer/interrupt
                CALL    EXEC_SUBJECT    ; execute & collect data
                CALL    RESTORE_TIMER   ; restore timer/interrupt
                CALL    EXEC_PRINT      ; execute data reduction
                                        ; and printout program
                INT     20H             ; terminate
PRF             ENDP
;-------------------------------------------------------------
;       returns unused memory to dos                          ;
;-------------------------------------------------------------
FREE_MEM        PROC    NEAR
                MOV     BX, OFFSET EOM  ; offset of top of memory
                MOV     CL, 4           ; shift count
                SHR     BX, CL          ; divide by 16 to get
                                        ; number of paragraphs
                ADD     BX, 1           ; in case not multiple of 16
                MOV     AH, 4AH         ; code for memory release
                INT     21H             ; do the shrink
                JNC     SUCCESS         ; go on if carry flag
                                        ; is zero (no error)
                MOV     AH, 9           ; code for print string
                MOV     DX, OFFSET MEM_ERR_STRNG
                                        ;  error message
                INT     21H             ; dos function call for print
                INT     20H             ; end if error returned
SUCCESS:        RET                     ; return
FREE_MEM        ENDP
;-------------------------------------------------------------;
;    run subject program under profiler                       ;
;-------------------------------------------------------------;
EXEC_SUBJECT    PROC    NEAR
                MOV     AX, CS          ; to set seg registers
                MOV     DS, AX          ; ds:dx point to asciiz
                                        ; string with name of
                MOV     DX, OFFSET SUBJECT_NAME  ; file to execute
                MOV     ES, AX                   ; es:bx point to
                MOV     BX, OFFSET EXEC_PARAMS   ; parameter block
                MOV     CX, CS:[2CH]        ; set segment address
                MOV     ENVIRON_SEG, CX     ; of passed environment
                MOV     COMMND_OFS, 80H     ; set offset and segment
                MOV     COMMND_SEG, CS      ; of passed command line
                MOV     FCB1_OFS, 5CH       ; set offset and segment
                MOV     FCB1_SEG, CS        ; of unopened fcb1
                MOV     FCB2_OFS, 6CH       ; set offset and
                MOV     FCB2_SEG, CS        ; segment of unopened fcb2
                MOV     AX, 4B00H           ; set ax register for load
                                            ; and execute dos call
                MOV     ACCUM_FLAG, 1       ; turn on address accumulation
                                            ; flag
                MOV     SAV_SP, SP    ; save stack pointer
                INT     21H           ; do interrupt
                MOV     AX, CS        ; restore
                MOV     ES, AX        ; segment registers
                MOV     DS, AX        ; and stack
                MOV     SS, AX
                MOV     SP, SAV_SP
                MOV     ACCUM_FLAG, 0 ; turn off address
                                      ; accumulation flag
                RET
EXEC_SUBJECT    ENDP
;-------------------------------------------------------------
EXEC_PRINT      PROC    NEAR
                MOV     AX, CS          ; to set seg registers
                MOV     ES, AX
                MOV     DS, AX
                MOV     SS, AX
                MOV     DS, AX                  ; ds:dx point to
                MOV     DX, OFFSET PRINT_NAME   ; asciiz string with
                                                ; name of file to
                                                ; execute
```

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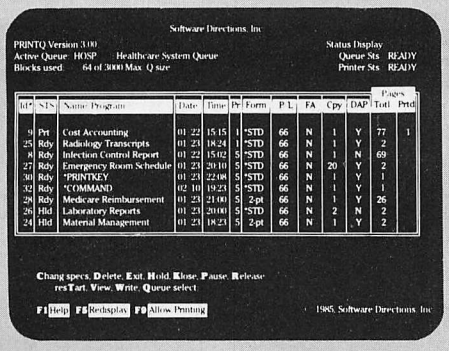

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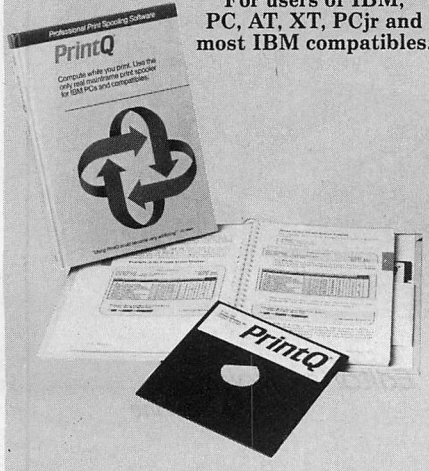

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```
; move segment and offset of data into words 0-3 of cs:5ch (fcb1)
                MOV     AX, OFFSET DATA_TABLE   ; offset of data
                MOV     BX, 5CH                 ; offset into cseg
                MOV     CS:[BX], AX             ; move offset into fcb1
                MOV     AX, CS                  ; cs to ax
                MOV     CS:[BX+2], AX           ; move cs into fcb1

        divide table offset by 4 to get number of samples
                MOV     CL, 2                   ; shift count to cl
                SHR     TABLE_OFS, CL           ; shift to divide
                MOV     ES, AX                    ; es:bx points to
                MOV     BX, OFFSET EXEC_PARAMS     ; parameter block
                MOV     CX, CS:[2CH]        ; turn off address
                MOV     ENVIRON_SEG, CX     ; accumulation flag
                MOV     COMMND_OFS, 80H     ; set offset and segment
                MOV     COMMND_SEG, CS      ; of passed command line
                MOV     FCB1_OFS, 5CH  ; set offset and segment
                MOV     FCB1_SEG, CS    ; to unopened fcb1
                MOV     FCB2_OFS, 6CH   ; set offset and segment
                MOV     FCB2_SEG, CS    ; of unopened fcb2
                MOV     SAV_SP, SP      ; save stack pointer
                MOV     AX, 4B00H
                INT     21H             ;dos function call
                MOV     AX, CS
                MOV     DS, AX     ; restore segment registers
                MOV     ES, AX     ; and stack pointer
                MOV     SS, AX
                MOV     SP, SAV_SP
                RET
EXEC_PRINT      ENDP
;---------------------------------------------------------------
;       replaces the existing timer 0 countdown value and the    ;
;       existing interrupt 8                                     ;
;---------------------------------------------------------------
REPLACE_TIMER   PROC    NEAR
        PUSH    DS              ; save data segment
```

```
        CLI                     ; disable maskable interrupts
;       replace timer 0 countdown to (maybe) speed up timer
                MOV     AL,  36H        ; timer 0, mode 3, will send
                                        ; lsb, msb
                OUT     43H, AL         ; write mode control word
                                        ; to timer
                MOV     BX,  New_Timer_Count
                                        ; new countdown value
                MOV     AL,  BL         ; lsb of new_timer_count
                OUT     40H, AL         ; write lsb to timer 0
                MOV     AL,  BH         ; msb of new_timer_count
                OUT     40H, AL         ; write msb to timer 0
;       replace existing interrupt 8
                XOR     AX, AX          ;0 to ax
                MOV     DS, AX          ; seg for interrupt vectors
                MOV     AX, DS:[20H]    ; contents of 0:20 to ax
                MOV     CS:OLD_OFS, AX  ; save in old_ofs
                MOV     AX, DS:[22H]    ; contents of 0:22 to ax
                MOV     CS:OLD_SEG, AX  ; save in old_seg
                MOV     DS:[20H], OFFSET NEW_TIMER      ; new offset
                MOV     DS:[22H], CS                    ; new seg
                STI                     ; enable maskable interrupts
                POP     DS              ; restore data segment
                RET                     ; return
REPLACE_TIMER   ENDP
;---------------------------------------------------------------;
;       restores the original interrupt 8 and the timer 0        ;
;       countdown to the power-up value                          ;
;---------------------------------------------------------------;
RESTORE_TIMER   PROC    NEAR
                CLI                     ; disable maskable interrupts
;       restore interrupt 8
                MOV     AX, 0           ; 0 to ax
                MOV     DS, AX          ; segment for interrupt
                                        ; vectors
                MOV     AX, CS:OLD_OFS  ; old_ofs to ax
                MOV     DS:[20H], AX    ; contents of ax to 0:20
```

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```
                MOV     AX, CS:OLD_SEG  ; old_seg to ax
                MOV     DS:[22H], AX    ; contents of ax to 0:22
;       restore timer 0 countdown to power-up value
                MOV     AL,  36H        ; timer 0, mode 3, will
                                        ; send lsb, msb
                OUT     43H, AL         ; write mode control word
                                        ; to timer
                MOV     AL,  0          ; lsb and msb of 0
                OUT     40H, AL         ; write lsb to timer 0
                OUT     40H, AL         ; write msb to timer 0
                STI                     ; enable maskable interrupts
                RET                     ; return
RESTORE_TIMER   ENDP
;-------------------------------------------------------------;
;       replaces old timer interrupt.  accumulates data if    ;
;       accum_flag is set, and jumps to previous int 8 if     ;
;       timing is appropriate                                 ;
;-------------------------------------------------------------;
NEW_TIMER       PROC    NEAR
                CMP     CS:ACCUM_FLAG, 0        ; check to see if
                                                ; we accumulate
                JE      DO_OLD_INT8?    ; skip accumulate if 0
                CALL    ACCUMULATE              ; if not 0,
                                                ; accumulate data
DO_OLD_INT8?:                   ; check to see if we do old int 8
                INC     CS:TIMER_COUNT          ; increment counter
                CMP     CS:TIMER_COUNT, Number_Of_Ticks
                                                ; do it this tick?
                JNE     SKIP_OLD_INT8           ; skip int 8
                                                ; if not time
                MOV     CS:TIMER_COUNT, 0       ; reset counter to
                                                ; zero
                JMP     CS:DWORD PTR OLD_INT8   ; jump to old
                                                ; interrupt 8
SKIP_OLD_INT8:
                PUSH    AX                      ; save ax
                MOV     AL, 20H                 ; end of interrupt
                                                ; code
```

```
                OUT     20H, AL                 ; send eoi to 8259
                POP     AX                      ; restore ax
                IRET                            ; return from this
                                                ; interrupt
NEW_TIMER       ENDP
;-------------------------------------------------------------
ACCUMULATE      PROC    NEAR
;       accumulate data at clock interrupt
                PUSH    AX                      ; push registers
                PUSH    BX
                PUSH    CX
                PUSH    BP
;       check for table overflow
                MOV     AX, CS:MAX_OFS          ; load ax
                CMP     CS:TABLE_OFS, AX        ; have we reached
                                                ; end of table?
                JAE     END_ACCUM               ; if so, skip
                                                ; data accumulate
;       accumulate samples
                MOV     BX, CS:TABLE_OFS        ; table address to bx
                MOV     BP, SP                  ; sp to bp
                MOV     AX, SS:[BP+10]          ; load ax with
                                                ; interrupted ip
                MOV     CS:WORD PTR DATA_TABLE[BX], AX  ;save ip
                MOV     AX, SS:[BP+12]          ;load ax with
                                                ; interrupted cs
                MOV     CS:WORD PTR DATA_TABLE[BX+2], AX ;save cs

                ADD     CS:TABLE_OFS, 4         ;increment offset
                                                ; into table
END_ACCUM:
                POP     BP                      ;restore registers
                POP     CX
                POP     BX
                POP     AX
                RET
ACCUMULATE      ENDP
;-------------------------------------------------------------;
;       DATA AREA                                             ;
;-------------------------------------------------------------;
SUBJECT_NAME    DB      'SUBJECT.COM'   ;asciiz name of subject
                DB      0               ;asciiz terminator
MEM_ERR_STRNG   DB      'ERROR SHRINKING MEMORY - PROFILE ENDS$'
EXEC_PARAMS     EQU     $               ;parameters passed
ENVIRON_SEG     DW      ?               ;to exec'ed programs
COMMND_OFS      DW      ?
COMMND_SEG      DW      ?
FCB1_OFS        DW      ?
FCB1_SEG        DW      ?
FCB2_OFS        DW      ?
FCB2_SEG        DW      ?
SAV_SP          DW      ?               ;word to save stack pointer
                                        ;  across exec's
PRINT_NAME      DB      'LISTPRF.COM'   ;asciiz name of data
                                        ;reduction & printout program
                DB      0               ;asciiz terminator
TIMER_COUNT     DW      0               ;counts timer interrupts
                                        ; since
                                        ;  last jump to original
                                        ; interrupt 8
ACCUM_FLAG      DW      0               ; flag to trigger address
                                        ; accumulation
OLD_INT8        EQU     $    ;address of old timer interrupt
OLD_OFS         DW      ?    ;offset of old timer interrupt
OLD_SEG         DW      ?    ;segment of old timer interrupt
OUR_STACK       DD      100H DUP (0)    ;space for our stack
END_STACK       EQU     $               ;set sp to this offset
MAX_OFS         DW      Table_Size      ;max offset from beginning
                                        ; of data table
TABLE_OFS       DW      ?               ;current offset into
                                        ; data table
DATA_TABLE      DB      Table_Size DUP(0)
EOM             EQU     $               ;end of memory
PSP             ENDS
;
                END     PRF
```

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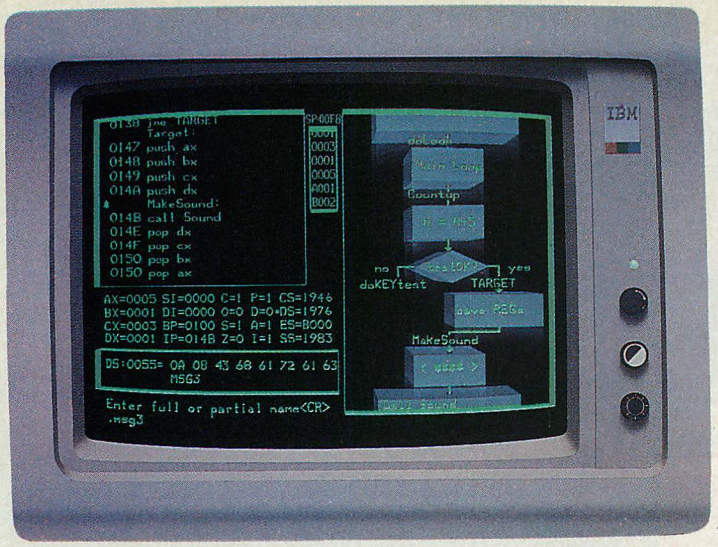


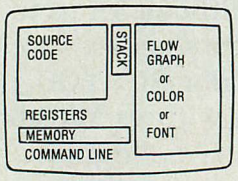
dBug/EGA

The only debugger designed especially for the new EGA graphics standard is now available from Cybernetic Micro Systems

only **$99** (not copy protected)

User Interface

dBug/EGA is a program that uses six dedicated windows to step through your code:



Font Creation

dBug/EGA allows you to create new characters easily. Issue the "F" command. Then use the cursor keys to select a pixel in the 8 x 14 font array. Then "+" or "–" will set or reset the pixel. When you finish creating the new character, "ESC" will save it, and your program can now use it. New fonts can be saved to disk and then reloaded for future use.

Color Palette

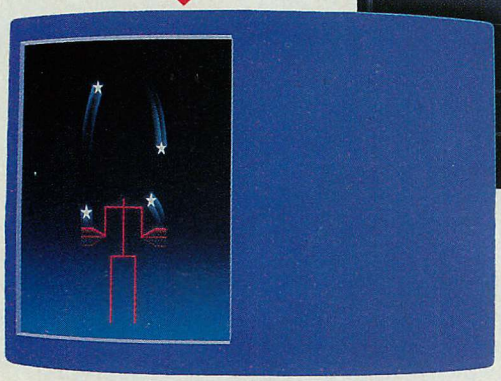
dBug/EGA allows you to easily alter any color in any palette register by typing Cn=color, where Cn stands for register #n. For example, C3=2 will change color register 3 to green (=2). This feature allows you to quickly try new color schemes in your graphics program using up to 16 color registers.

Multi-Window Debugging

dBug/EGA saves the "User Screen" when a breakpoint is reached and replaces it with a multi-window "debug Screen" for single stepping through Assembly Language Source Code that you write. dBug/EGA displays your names and labels along with registers, stack, and memory values. dBug/EGA even draws a flowgraph for your documentation. On-line help is always available, and the single-key commands will prompt for any required parameters. The debug screen and application (user) screen are maintained separately, and either can be viewed on command.

Animation

A free demo program, the Star Juggler, provides source code to show you how to take advantage of EGA features as you learn to use the debugger. A 100+ page manual, with numerous screen dumps, walks you through the demo.



Animated Demo (Free with dBug/EGA)

Font Creation

Color Palette

FlowGraph

Requires IBM PC-XT-AT or clone, 256K RAM, EGA card+256K, DOS 2.0 or newer.

dBug/EGA	$99
dBug88 (non-EGA version)	$99
EGA utility source code	$99

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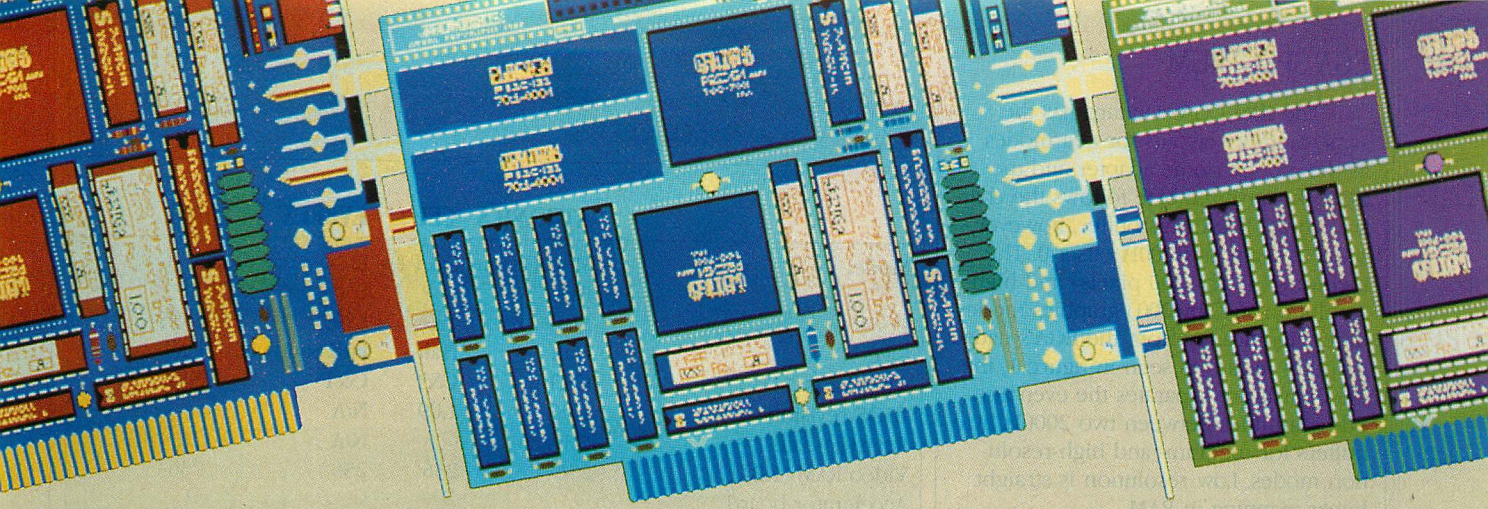

EVALUATING THE EGA

The EGA Spectrum

These graphics boards not only implement the EGA standard, but also offer emulation of earlier adapters and some CPU acceleration features.

Part 2

JOHN T. COCKERHAM

After IBM introduced its Enhanced Graphics Adapter (EGA), vendors scrambled to come up with compatible boards for what they realized would eventually become the graphics standard. The first round of boards were bare-bones implementations of the EGA standard, largely structured around a compatible chip set produced by Chips & Technologies (C&T). Part 1 of this article measured several of those C&T boards against IBM's original EGA (see "The EGA Spectrum," John T. Cockerham, October 1986, p. 80).

The next round of EGA-compatible boards, reviewed this month, takes another step by emulating earlier video boards and CPU acceleration features. Unlike the EGA, these boards can map video RAM and configure or create I/O registers forcing the EGA to act like the IBM Color Graphics Adapter (CGA) or the Hercules Graphics Card (HGC).

These more advanced boards include ATronics International's Mega-Graph Plus; CEI's EGA-1; the Enhanced Evergraphics from Everex Systems; EPIC half-card from NSI Logic; Orchid Technology's EGA; Paradise Systems' Auto-Switch; SigmaEGA! from Sigma Designs; Tseng Laboratories' EVA and EVA with CM II; Video7's VEGA and Quadram's QuadEGA+ (actually the same board); and VuTek's E.G.A. (an early version of NSI's EPIC full-card, but different enough to be reviewed on its own). In addition, two turbocharged boards, offering CPU accelerators as well as EGAs, are reviewed: Orchid's Turbo EGA; and Sigma Design's TurboEGA!. Table 1 summarizes the features of this second set of boards.

A brief review of the architectures of the first generation display adapters will aid the understanding of how the EGA emulates these earlier adapters.

The locations of the index register, data register, and several other key CRT controller (CRTC) registers are not the same for the CGA, HGC, and IBM Monochrome Display and Printer Adapter. Hence, additional intelligence is needed in the form of emulation hardware and software.

The EGA standard chip set provides all of the memory mapping modes of the CGA to aid in its BIOS-level emulation. Memory mapping of the Hercules graphics modes is also provided by the EGA hardware.

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The IBM CGA standard has the same memory layouts for text modes as the monochrome adapter and the EGA: the attribute byte follows the character byte. The CGA's buffer, however, starts at segment B800H offset 0. The medium- (320-by-200 pixels) and high-resolution (640-by-200) graphics modes differ significantly from the EGA's native graphics mode. As seen in figure 1, the CGA hardware separates the even and odd scan lines between two 2000H byte buffers for medium- and high-resolution modes. Low resolution is straight linear mapping in RAM.

The interpretation of the video buffer's contents changes depending on the graphics mode selected. In low-resolution, 16-color mode (unsupported by the PC ROM BIOS), four bits of each byte map to a two-by-two pixel area on the CRT by using direct register addressing. In medium-resolution mode, two bits are mapped to each pixel on the screen, affording a palette of four colors. In CGA high-resolution graphics modes, the pixels map one for one from left to right within the byte. Each pixel is either on or off, and while the on color may be any of the 16 IRGB colors, the off color is always black.

The Hercules card uses the same Motorola 6845 CRTC that the CGA uses. The alphanumeric display mode works the same as IBM's monochrome adapter. In graphics modes, however, the scan-line-to-byte correspondence differs from either the EGA or the CGA graphics modes. As depicted in figure 2, the video data for the horizontal scan lines are split among four 8KB buffers. Like the monochrome adapter, the 6845 on the HGC is mapped at I/O address 3B4H and 3B5H. The two mode registers are mapped at 3B8H and 3BFH.

The mapping of pixels to bits is left to right within a byte, one pixel per bit. In alpha modes, the character font is designed with a nine-pixel-wide box. As in the monochrome adapter, the ninth pixel is blank except when displaying graphics characters in which portions of the character must connect with adjacent characters at the right boundary of the character box, requiring that the ninth pixel replicate the eighth.

ADAPTER COMPATIBILITY

EGA emulation of earlier boards is not a trivial problem. For some users, BIOS emulation alone of the CGA is insufficient. Many game programs, for example, directly access the CGA's registers, creating nonstandard display modes, or they use the colorful low-resolution graphics mode. As shown in figure 3 the registers of the CGA and HGC differ from the EGA's in both address and purpose. This difference must be rectified during emulation. Several of the HGC and the CGA I/O registers do not exist in the EGA implementation.

Some of the important registers occupy the same relative positions in both boards. (The notation used here for register addresses is <Data Register>.<Index Register Value>). The CGA provides horizontal screen centering (CGA horizontal sync position 3D5.02) for composite video displays. The EGA does not support composite video output, and programs that attempt screen centering on 3D5.02 will blank the screen because 3x5.02 specifies the start of horizontal blanking on the EGA. The CGA mode select register at 3D8H does not correspond to the EGA register set; disabling blinking by writing to 3D8H has no effect. The HGC provides two registers at I/O address 3D8H and 3DFH that control mode and memory addressing—missing in the EGA.

The CRT and attribute controllers need to be programmed to reflect the HGC memory mapping. The palette has to be set to display a pixel when the bit is set in video page 0, regardless of the settings of the other planes. The HGC offers 64KB of video RAM at B000H, as two 32KB pages. The EGA limits the pages at B000H or B800H to 32KB.

Although the IBM EGA does not directly support the HGC, Hercules emulation in the C&T chip set is allowed only by the grace of IBM's design. IBM obscurely documents the alternate display mapping modes in the *Technical Reference*. Two bits control the display addressing in the CRTC mode register 3x5.17. Compatibility mode support (bit 0), when set to 0, maps the addresses generated by the EGA during accesses to the video bit planes to follow the CGA graphics scheme. The hardware does this by mapping the row scan counter bit 0 to memory address bit 13. This mapping splits the display RAM into two 2000H portions with the even

TABLE 1: *EGA Board Features*

	ATRONICS	CEI	EVEREX	NSI
Model	MegaGraph Plus	EGA-1	Enhanced Evergraphics	EPIC
Price	$549	$595	$599	$395
Size	Half	Half	Full/Sandwich	Half
Chip basis	C&T	C&T	C&T	NSI
BIOS revision	1.06	1.09	N/A	○
Revision date	5/14/86	○	N/A	7/28/86
Video RAM (KB)	256	256	256	256
Accelerator board	○	○	○	○
Feature connector	●	○	○	●
RCA jacks	●	○	○	●
Light-pen connector	●	●	●	●
Parallel port	○	○	●	○
Serial port	○	○	○	○
Clock	○	○	○	○
ROM disable	○	○	○	●
Diagnostic software	○	○	○	○
DIP switch through bracket	●	●	○	●
PC vertical interrupt correct	●	●	○	●
Soft boot correct	○	○	○	●
Emulation type	Software[b]	○	Two adapters	Hardware
CGA low-resolution emulation	○[b]	○	○	●
CGA emulation	○[b]	○	○	●
HGC emulation	○[b]	○	●	●
Other	○[b]	○	○	○
Boot emulation	○[b]	○	○	●
BIOS bugs	T	F,S,A,I	S	C
Chip bugs	○	○	○[d]	Line 640

● = Yes
○ = *No*
A = *Alt-PrtSc*
C = *BIOS clears other display on boot*
F = *Font fudging*
I = *No INT 42H pass-through*
S = *Save area*
T = *Text not painted in graphics modes*

ORCHID TECHNOLOGIES		PARADISE	SIGMA DESIGNS		TSENG	VIDEO7/ QUADRAM	VUTEK
Orchid EGA	Turbo EGA	Autoswitch	SigmaEGA!	TurboEGA!	EVA	VEGA/QuadEGA+	E.G.A.
$495	$945	$599	$495	$899	$525	$499/495	$460
Full	Full	Half	Half	Full	Full	Half[a]	Full
C&T	C&T	Paradise	C&T	C&T	Tseng	C&T	NSI
1.3	1.1	1.0	VX126+	1.22	1.0	1.06	○
○	○	○	○	○	5/6/86	○	10/31/85
256	256	256	256	256	256	256	256
○	6-MHz 286	○	○	10-MHz 286	○	○	○
●	●	●	●	●	●	●	●
●	●	●	●	○	●	●	●
●	●	●	●	●	●	●	●
○	○	○	○	○	●	○	○
○	○	○	○	○	○	○	○
○	○	○	○	○	○	○	○
○	○	○	○	○	○	○	●
○	○	○	●	○	●	●	○
●	●	●	●	○	○	●	●
●	●	●	●	●	●	○	●
○	●	●	○	●	●	○	○
Software	Software	Software	Software	Software	Trap firm[c]	Software	Hardware
○	○	○	○	○	●	○	●
●	●	●	●	●	●	●	●
●	●	●	●	●	●	●	●
○	○	Plantronics	○	○	○	○	○
○	○	●	○	○	●	○	●
S,A	S,A	I	○	○	S,A	S,A	N/A
○	○	Pan, Blink	○	○	Font snow	○	Pan, Split, Line 350

[a]*Also has full card models* [b]*Unable to get emulation to run* [c]*Optional CM II compatibility module* [d]*Board-level scrolling bug*

Only the EPIC, E.G.A., and EVA boards are able to provide CGA, HGC, and CGA low-resolution emulations.

numbered lines in the first buffer and the odd lines in the second.

Bit 1 in the CRTC mode register, called the select row scan counter, maps row scan counter bit 1 to memory address bit 14. Together with bit 0, the two can specify addressing modes compatible with the Hercules video RAM access method by providing four 2000H buffers (see figure 2).

In high-resolution CGA graphics modes, the pixel-to-byte mapping is one for one, just like the EGA in its native mode. For emulating medium-resolution CGA graphics on the EGA, the EGA graphics controller's mode register (3CF.05) specifies the two-bits-per-pixel arrangement that this mode requires. Standard EGA hardware cannot emulate the low-resolution mode of a CGA.

The HGC high-resolution graphics mode paints 720-by-348 pixels on the screen. The EGA has no problem displaying a 720-pixel-wide horizontal line on a monochrome display. Table 2 gives a set of parameters for the EGA that will create an HGC-compatible display mode. The horizontal display end (3B5.01) is set to specify a 90-byte character row length by putting 59H in 3B5H. The horizontal total is calculated by dividing the dot clock frequency (16.257 MHz) by the horizontal scan rate of the monochrome monitor (18.432 KHz), yielding 110 characters. This leaves 20 character times to take care of overscan and horizontal retrace.

The other registers—horizontal/vertical retrace start and end, vertical total, and horizontal/vertical blanking—should be set to the values shown in table 2. Operating a display with the dot clock at 16 MHz allows the monochrome adapter to paint 720 pixels across the screen.

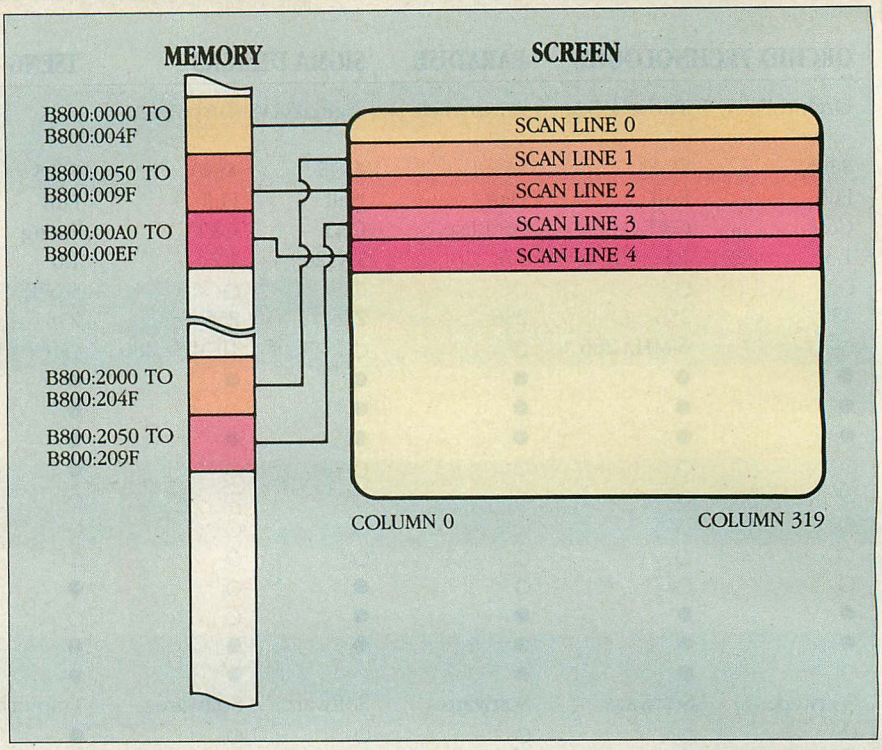
The monochrome and color displays differ in the maximum timing rates they can handle: 16 MHz for the monochrome display (the EGA's on-board dot clock provides this) and 14 MHz for the color display (which is, conveniently, the timing rate for the PC motherboard crystal). The monochrome display runs at a slower clocking rate to perform high-resolution graphics, BIOS mode 15. The EGA miscellaneous output register (3C2H bits 2 and 3) selects the clocking oscillator: a 0 value specifies the motherboard dot clock; a 1 specifies the on-board dot clock; and a 2 specifies that the dot clock is to be taken from an oscillator signal fed in through the feature connector from an external source.

TRAPPING TECHNIQUES

The compatibility problem consists of three parts: display RAM addressing, I/O register addressing and deployment, and chip register interpretation. Display RAM addressing is handled by the EGA standard chip set. I/O register addressing and deployment has to be solved at the board level using extra chips or programmable array logic (PAL) to create the additional registers.

After producing the additional registers the final problem remains: inter-

FIGURE 1: *CGA Memory Mapping*



The scan lines with even numbers are mapped into memory starting at B800:0000, and those scan lines with odd numbers start at B800:2000.

preting the user's intentions and creating the same effect on the EGA hardware. Three potential designs will work, the first two of which can be based solely on the C&T EGA chip set: (1) trapping software in which the adapter issues an interrupt when the user reprograms certain registers, and the interrupt handler then takes care of the details; (2) trapping hardware in which the board itself deals with redirecting and reinterpreting the registers as they are programmed in realtime; (3) true hardware, where the adapter configures itself among the several different display chips that exist on the adapter—a mode register instructs the board to plug in different display chip sets.

In creating hardware to emulate earlier boards, the designer needs to provide a means of intercepting I/O accesses to the I/O registers that do not exist on the EGA. The emulation software needs to communicate with the adapter to start, stop, and sense mode trapping. For hardware economy, most designers choose to locate the read/write I/O register in the vicinity of the EGA address space.

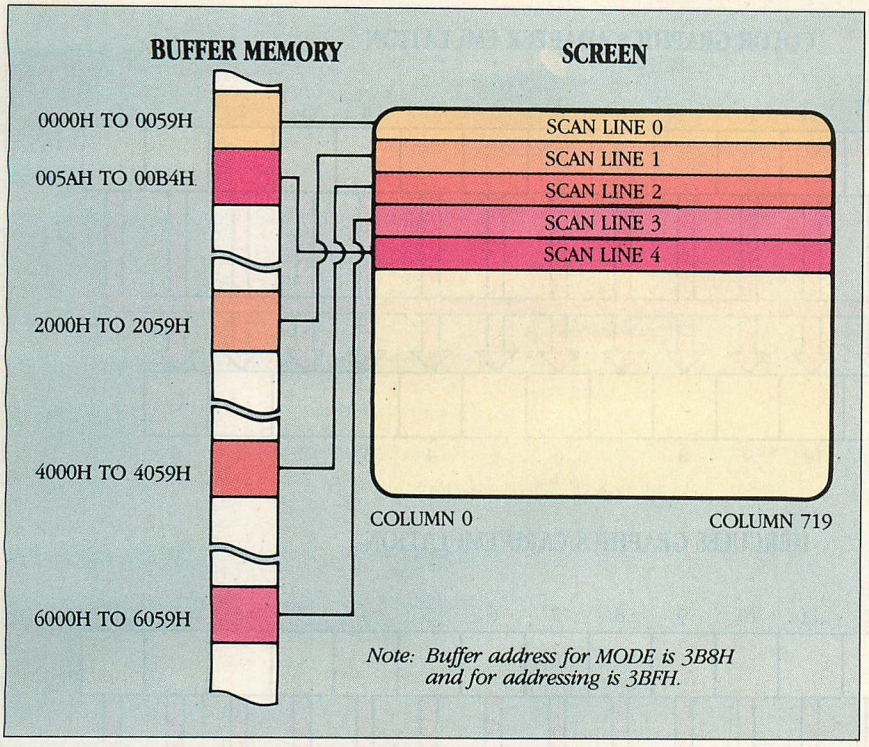
For the CGA, the registers sensed are usually the mode and color select registers. For the HGC, the mode (3B8H) and the addressing mode (3BFH) registers are usually sensed.

To invoke emulation, the user runs a mode-setting program. Some install themselves as RAM-resident interrupt handlers, while other emulation packages are actually included on the ROM BIOS of the EGA. The software instructs the board to configure itself to the requirements of the desired adapter. The board's chips create dummy registers in the I/O address space. When the user program writes to one of these registers, the interrupt routines take control, examine a status register to determine what the I/O write attempted to do, and then reconfigure the EGA appropriately.

The color select register (3D9H) specifies the colors for the modes of the CGA, so the emulation handler need only change the EGA palette. The mode control register (3D8H) chooses among the alphanumeric and graphics modes that the adapter implements—easy changes among the EGA modes. The CGA status register (3DAH) resides at the same I/O address as the EGA status register, and bits 0-4 of the two registers have the same meanings.

For the HGC only two bits need sensing in the mode register (3B8H): bit 5, which enables blinking, and bit 1, which turns on graphics. When the user specifies graphics mode, the interrupt handler must reconfigure the board, setting up the display addressing mode

FIGURE 2: *HGC Memory Mapping*



The mapping for HGC emulation is in four sequential buffers. The start of the buffer is selected in address 3BFH at B000H or B800H, making two 32KB buffers.

and respecifying the video parameters. The addressing register (3BFH) specifies the size and the CPU address of the video RAM pages on the display adapter. The software needs to know whether or not a physical CGA is installed in the system in addition to the EGA. If a CGA is present, the HGC emulation is limited to 32KB of video RAM emulation mode; the HGC buffer at segment B000H begins to overlap the CGA buffer at segment B800H after 32KB.

Most designers implement emulation interception via the nonmaskable interrupt (NMI) because any program manipulating the display must be free to turn off ordinary interrupts without disabling the display. The NMI method is fraught with danger, however. Several popular applications, such as dBASE III, already usurp NMI to prevent curious users from tracing its code with NMI-based debuggers.

A few emulation routines take care of NMI theft by restoring the NMI with each tick of the system clock. If an application is set up to retrieve the NMI with each clock tick, the emulation software and the application will lock up the system while they are stealing the NMI from one another at the rate of 18 times per second.

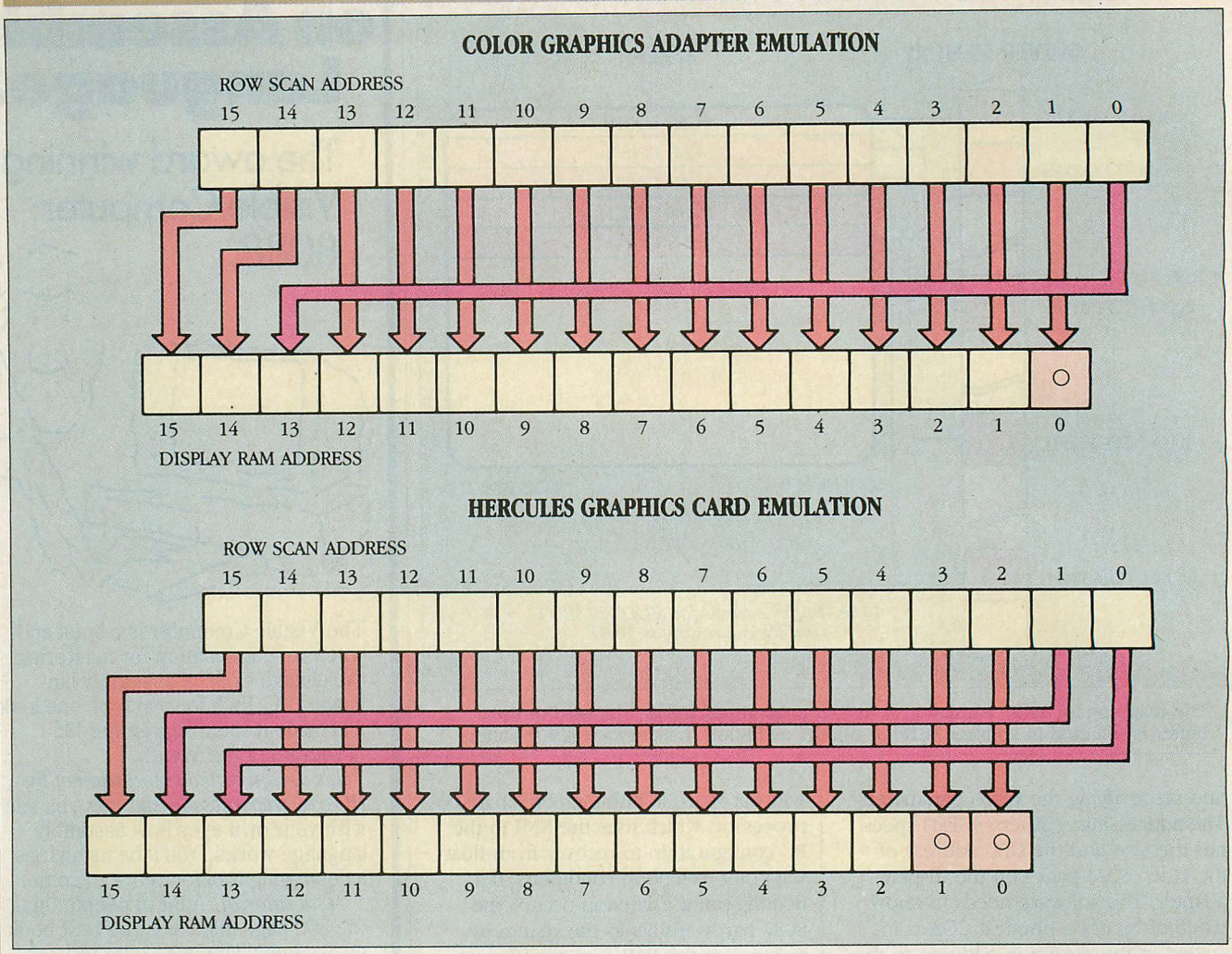
Perhaps worst of all, some EGA boards require the NMI exclusively and will not share it with the 8087 math coprocessor, which uses the NMI in the PC configuration to recover from floating-point exception conditions. If a floating-point exception occurs, the 8087 hardware hangs the system by waiting for the NMI service routine.

Tracing emulation software with a debugger is difficult, because the NMI is used by both the debugger and the emulation scheme. Manufacturers are reluctant to share their emulation methods. As a result, the description of the above methods is based on the boards' performances on various tests and from reading the disassembled code rather than actually tracing it.

Some of the adapters cannot install software during boot-up of the system; they require DOS to run before the drivers can be installed. Again, for most applications this is not a problem. However, game programs that are started by warm-booting the system cannot be run using some of these boards because the emulation driver cannot be insinuated between the game program and the hardware. ATronics and Paradise provide a system that can set up emulation from DOS and then retain it through a soft boot, allowing boot-only games to run under CGA emulation.

The only trapping-hardware board reviewed is Tseng Labs' EVA. It requires

FIGURE 3: *Emulation Addressing Techniques*



The EGA maps the row scan counter to the display RAM address and bits 0 and 1 of the row scan counter to bits 13 and 14 of the memory address register for the HGC; bit 0 is mapped into bit 13 of the memory address register for the CGA.

a $50 daughterboard, called the CM II, to handle emulation. The CM II incorporates a Z-80 microprocessor that intercepts I/O instructions intended for older display adapters and holds the system CPU while the EVA with CM II reinterprets the I/O instruction. Using the CM II, the EVA correctly implements a complete emulation of the CGA and HGC, including all CRTC register manipulations. To support the on-board microprocessor's programs the ROM BIOS on the EGA card was increased to 32KB. This system may cause problems in realtime, interrupt-driven, multitasking environments if the board holds the CPU for too long a time.

A complete hardware solution to the emulation problem is implemented by NSI's EPIC board. Apparently, the mode is controlled through an unused CRTC register of the EGA register file. The board becomes a CGA or monochrome adapter upon command.

MEASURING LIMITS

The boards evaluated here were tested with the same programs as used on the C&T-based boards reviewed last month. The basic set of tests included operation under DOS, Microsoft Windows, Microsoft Word, the custom program EGATEST, IBM's FantasyLand, Media Cybernetics' Dr. Halo, EGA Paint by RIX SoftWorks, STSC's APL and Statgraphics, Fansi-Console by Hersey Microconsulting, and Graphic Software Systems Computer Graphics Interface (CGI). Table 2 summarizes the test results. (For a complete discussion of these tests and a Modula 2 program listing of EGATEST and several subroutines, see "The EGA Standard," John T. Cockerham, October 1986, p. 48.)

In addition to the aforementioned tests, the advanced boards were submitted to a new set of tests to measure further the limits of their emulation capabilities. Three game programs—Moonbugs, Centipede, and STYX—along with the low resolution Mandelbrot program (see "Sixteen-color Graphics," Programming Practices, August 1986, p. 159) were used in the testing process. These programs determine whether the emulation routines can handle complete reprogramming of the CRTC properly by testing the adapter with a larger or smaller screen size. STYX runs in medium resolution for its start-up screen and then in low-resolution, 160-by-100, 16-color mode, which the BIOS does not support. The Mandelbrot set also uses the low-resolution 16-color mode. The game programs color the screen using the CGA palette and therefore test whether the emulation software remaps the palette to CGA standard. STYX also tests whether or not CGA emulation can be installed at boot-up time.

HGC emulation was tested with CGI, Microsoft Word, and Windows—all installed in Hercules mode. Because

several adapters tested for this article were based on chip sets other than C&T, additional tests were written to ascertain the completeness of those chip sets' EGA hardware implementation. These tests checked the graphics mode blinking capabilities in monochrome as well as in color mode. The test results indicate that emulation exacts a significant overhead penalty during intensive use of the BIOS.

ATronics International, Inc. The MegaGraph Plus from ATronics is a half-size card based on the C&T chip set. It is shipped with 256KB of video RAM. The monitor connector, DIP switch access, and the two RCA jacks are on the board bracket. All components are surface mounted. The two jumpers that control I/O addressing and monitor type are easily found. The BIOS, dated 5/14/86, was written by Eden Software.

Problems uncovered during testing for this article included difficulties in panning through FantasyLand's large virtual screen and in switching between the monochrome display and the MegaGraph Plus. Replacement boards solved these two problems, but a third one was uncovered by EGATEST. The write character routines in graphics modes do not put the characters into video page 0. Any text written to the screen through the BIOS while in any EGA graphics mode simply does not appear. In addition, the board misinterprets the PC reboot flag, forcing a full memory test at the warm boot.

The Megagraph Plus contains emulation software for HGC and CGA modes in its ROM BIOS. CGA low resolution is not available. The manual alleges that the emulation mode can be called up at boot time by setting the mode switches and pressing F2. This did not work, however. ATronics said the Western Digital hard-disk BIOS writes over ROM BIOS locations during boot-up, thus disabling emulation mode. An improved mode-setting program was promised, but was not received in time to be reviewed here.

The board passed all tests of the EGA BIOS function. The score on the BIOS dot painting benchmark was an average 28.6 seconds.

CEI, Gmbh. Computer Elektronik Infosys Gmbh of West Germany markets add-on boards for the PC market in Europe. Its EGA-1 is an example of German precision; the components are compactly and neatly placed on the board. The RAM and graphics chips are surface mounted. The BIOS and four PALs are socketed. The one jumper located next to the configuration switches specifies

TABLE 2: *CRT Controller Differences*

CGA AND HERCULES		EGA	
Index offset into CRTC chip	**6845**	**Index offset into CRTC chip**	**6845**
0	Horizontal Total	0	Horizontal Total
1	Horizontal Displayed[a]	1	Horizontal Display End
2	Horizontal Sync Position	2	Start Horizontal Blank
3	Horizontal Sync Width	3	End Horizontal Blank
4	Vertical Total	4	Start Horizontal Retrace
5	Vertical Total Adjust	5	End Horizontal Retrace
6	Vertical Displayed	6	Vertical Total
7	Vertical Sync Position	7	Overflow
8	Interlace Mode	8	Preset Row Scan
9	Maximum Scan Line	9	Max Scan Line
A	Cursor Start	A	Cursor Start
B	Cursor End	B	Cursor End
C, D	Start Address	C, D	Start Address
E, F	Cursor Address	E, F	Cursor Address
10, 11	Light Pen	10, 11	Light Pen (Read)
		10	Vertical Retrace Start (Write)
		11	Vertical Retrace End (Write)
		12	Vertical Display End
		13	Offset
		14	Underline Location
		15	Start Vertical Blanking
		16	End Vertical Blanking
		17	Mode Control
		18	Line Compare

All numbers are in hexadecimal.
[a]Horizontal Displayed and Horizontal Display End serve the same function, but the individual documentation names them differently.

The registers shown in the shaded blocks have different meanings for the CGA/HGC and the EGA; therefore, direct emulation is not possible.

enhanced monitor operation. No feature connector is included, and the I/O addresses cannot be changed. No additional hardware options such as ports or a clock are available. The EGA-1 uses the C&T chip set on a half-length card and comes fully configured with 256KB of video memory.

The reviewed board had faulty split-screen and smooth-picture scrolling features because the designers did not correct for a known C&T timing bug in the sequencer chip. Insertion of a capacitor solved these problems.

Phoenix Software Associates wrote the BIOS. In the undated version 1.09 a number of problems were detected. Font loading for the enhanced color modes does not work properly. In color modes, the BIOS incorrectly applies monochrome font expansion to the color mode font. Font expansion enhances readability in monochrome mode (which has a 9-by-14 character box) by expanding wide characters such as *M* and *W* to a full eight pixels. Using font expansion on an eight-pixel-wide character box forces wide characters to touch at their edges, reducing readability. Other difficulties included the BIOS save area features, which are not correctly applied after modifying the palette; further, the BIOS does not pass unrecognized function calls through to the old video interrupt, 042H. To its credit, the BIOS does correctly interpret the warm reboot flag.

The preliminary documentation for the board was freshly translated from German with several misspellings; however, the text is adequate for installation. Trade Ventures International of Herndon, Virginia, is CEI's U.S. agent.

Everex Systems, Inc. A full-length board with a three-quarter-length daughterboard, Everex's Enhanced Evergraphics

is actually two display adapters in one. The EGA portion is a 256KB C&T implementation that resides on the daughterboard. The main board contains a Hercules-like monochrome graphics card. These two independent display adapters make the Enhanced Evergraphics very useful in dual-display systems. Because of the unique dual-board structure, Everex removed the feature connector and the RCA plugs.

The main board includes a parallel printer port. The monochrome and printer port connectors on the board bracket leave no room for the EGA monitor connector. It is mounted in a stand-alone board bracket that is installed in a spare slot. The nine-pin D-connector on the main board bracket can serve either the monochrome or the EGA adapter if only one is to be used. Jumper blocks determine which adapter makes use of the monitor connector on the main board bracket.

The documentation is precise and clear. The four EGA configuration DIP switches are mounted on the EGA daughterboard and cannot be accessed through a hole in the board bracket. To change them, the entire board must be removed from the system. A set of eight jumper blocks must be moved to configure the adapter for single- or dual-display operation, monitor type, and parallel port assignment.

All of the basic EGA hardware functions test correctly. Running the font-changing routines of EGATEST produces slight changes in the fonts: bits drop out and are inappropriately set.

The Enhanced Evergraphics fails FantasyLand. When the board tries to pull up the first split screen, the picture is reduced to a jumble for a few seconds, then the screen whites out and begins rolling a blue, horizontal line.

All EGA functions are present in the BIOS. The save area routines do not fill in the save area during a mode set, but changing one of the palettes does work correctly. The BIOS passes unrecognized function calls to interrupt 42H. The PC reboot flag is misinterpreted, forcing full memory retest on warm boot. The dot timing score is a respectable 28.5 seconds.

No emulation modes are available with the Enhanced Evergraphics adapter. Instead, the user must toggle back and forth between the two adapters on this one board. Hercules modes are available in dual-monitor systems, but CGA emulation is restricted to BIOS-level functions. Tests for Hercules emulation were passed with ease.

NSI Logic, Inc. NSI's EPIC half-card is

based on a single-chip design and comes equipped with 256KB of video RAM. The feature connector and the RCA connectors are both in their correct locations. The eight-bank DIP switches can be accessed through the board bracket, thereby allowing easy mode changes. The only jumper, controlling monitor configuration, is located at the top of the card.

The board installs easily. The mode switches include the usual four that control boot-up mode as well as switches to select I/O address (when set to 2xxH this also disables the ROM BIOS) and emulation features that allow more than one board to be present.

The first versions of this chip set had several problems: the ninth dot in monochrome alpha modes was not present, split-screen pixel panning and scrolling did not work, and the board refused to run EGATEST at all. A subsequent version of the board had most of the kinks ironed out.

Color graphics mode blinking is still not present in the new hardware, even though monochrome graphics mode blinking works perfectly. On the bottom of the CRT, one line of overscan is absent. In monochrome graphics modes, the last pixel, the 640th, of the active display area is not displayed on the screen for all scan lines. Moreover, Hercules emulation is not provided.

TABLE 3: *EGA Board Test Results*

	ATRONICS	CEI	EVEREX	NSI
Model	MegaGraph Plus	EGA-1	Enhanced Evergraphics	EPIC
EGATEST[a]				
Scroll	Pass	Pass	Pass	Pass
Pan	Pass	Pass	Pass	Pass
Scroll/pan/cycle font	Pass	Pass	Fail	Pass
BIOS dot plot tests[b]				
DMA				
INLINE code	17.9	17.9	17.9	17.9
Subprogram	20.7	20.7	20.7	20.7
BIOS	28.6	37.0	28.5	41.4

[a] *Scroll indicates vertical soft scrolling. Pan indicates horizontal soft scrolling. The third test performs simultaneous scrolling and panning while cycling through fonts at a rate of 4.5 times per second.*

All of the standard BIOS tests were passed with ease. The BIOS passes on unrecognized function calls with a direct call on PC BIOS rather than through interrupt 42H. The reboot flag is interpreted correctly. The BIOS dot timing is similar to other boards in its category at 41.4 seconds.

The CGA emulation appears to be perfect—it even blinks the screen during scrolls; the EPIC BIOS passes video calls on to the PC BIOS when in emulation modes. The game programs Moonbugs and Centipede work correctly, and STYX and the Mandelbrot figures work in low-resolution mode. The emulation mode persists after a keyboard-induced reboot, allowing the user to set up an emulation mode and then boot off of a floppy disk. The disk accompanying the EPIC contains several small programs—and their source code—that demon-

ORCHID TECHNOLOGIES		PARADISE	SIGMA DESIGNS		TSENG	VIDEO 7/ QUADRAM	VUTEK
Orchid EGA	Turbo EGA	Autoswitch	Sigma EGA!	Turbo EGA!	EVA	VEGA/Quad EGA+	E.G.A.
Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
Pass	Pass	Fail	Pass	Pass	Pass	Pass	Fail
Pass	Pass	Pass	Pass	Pass	Pass	Pass	Fail
17.9	5.1 (17.9)	17.9	17.9	5.0 (17.9)	17.2	17.9	17.9
20.7	5.5 (20.7)	20.7	20.7	5.4 (20.7)	20.1	20.7	20.7
28.6	9.0 (28.6)	50.9	38.4	40.1 (44.0)	40.3	29.5	N/A

[b] *Timing results are given in seconds for 65,000 iterations of a dot plot in mode 16. The test machine was an IBM PC with 640KB of RAM.*

The timings for the EVA are better than all others except the turbo boards. Numbers in parentheses are for 8088 mode.

strate how to set up the various emulation modes of the board.

Orchid Technology, Inc. The Orchid EGA is a full-length C&T-based design with 256KB of video RAM. Both the monitor connector and the RCA jacks are located on the board bracket. The mode configuration switches are accessible through the board bracket. Setting two additional jumpers, one for monitor type and the other for emulation, completes the board configuration. Emulation software is provided in the form of a RAM-resident utility.

The manual that comes with the Orchid EGA is complete and well written. The disk that accompanies the board contains mode-setting routines, a screen-saving program that shuts off the screen if there has been no activity, and a program that displays the date of the PC ROM so the user can determine if a machine has an early version of ROM that is incompatible with the EGA BIOS.

This adapter emulates a CGA and an HGC through the NMI-trapping technique. The emulation covers the standard modes of the CGA. Unfortunately, the board does not share the NMI with the 8087 math coprocessor. Any floating-point errors cause the system to hang, requiring a power-off reboot. Low-resolution mode is not supported.

The board has a few BIOS bugs. The alternate print screen routines do not function correctly. The palette save

area functions correctly report a change in the palette. The mode-setting routines, however, do not fill the save area. The dot painting time is quite respectable at 28.6 seconds.

Paradise Systems. The Paradise AutoSwitch is a half-card EGA implementation that senses the nature of I/O register access and reconfigures itself to become, depending on which register is accessed, either an EGA, CGA, HGC, or Plantronics adapter. The board incorporates Paradise's proprietary EGA single-chip implementation, the PEGA-1.

The Paradise chip set differs from the EGA and C&T chip sets in several respects. One hardware bug of the EGA is not present: Paradise does not duplicate the first line of the high-resolution graphics split screen like the IBM EGA.

Some EGA features were omitted during the design of the PEGA-1. It does not perform color graphics mode blinking, and it implements horizontal pixel panning incorrectly. When the board pans horizontally, the hardware appears to preset the pixel that starts the horizontal line; at the end of the scan line, however, the Paradise CRTC enters overscan too early. This yields a right-hand overscan border that changes in size during the pan. The hardware ends the active display for the scan line when the comparator equals the logical line length rather than the logical line length *plus* the size of horizontal pan. The last character at the end of the line does not display until the hardware shifts out all of the pixels of the first character. Only then does the programming update the start address and reset the horizontal pixel pan to 0, allowing the last character on the line to appear. The net effect is that during scrolling, the right-hand margin appears to jump in character increments, as opposed to the smoothness of the other boards during horizontal pan. Paradise has said that future versions of the PEGA-1 will correct these problems.

The AutoSwitch includes 256KB of video RAM. All of the EGA hardware is present, including the feature connector and the RCA jacks. The board has one jumper, a five-switch bank of DIP switches, and a monitor selection toggle switch. The jumper specifies the address decoding of the board at either 2xxH or 3xxH. The configuration switches are accessible through the board bracket. The monitor-selection toggle switch is mounted on the board bracket. The first four DIP switches specify the boot-up mode of the board. The fifth enables the AutoSwitch feature for boot-up capabilities.

The rather brief, but complete, owner's manual provides the necessary instructions for installing the board and setting the configuration switches.

The AutoSwitch implements a trapping software approach to multiboard emulation. However, no RAM-resident mode software needs to be installed, because the emulation is done with an EGA BIOS routine. The emulation is adequate. Most standard programs work; low-resolution graphics are not supported, so STYX and the Mandelbrot figures do not display. HGC emulation appears to work correctly.

The Paradise BIOS contains its fair share of errors. The interrupt 42H pass-through of unrecognized BIOS functions calls is not present. (Interestingly, an earlier version of the BIOS contained a very nonstandard, direct jump into the PC BIOS video routine for handling unrecognized calls.) The save area functions all work correctly. The BIOS itself is quite slow, taking 50.9 seconds to paint the 65,000 pixels in EGATEST.

The AutoSwitch comes with a disk containing the program PEGA.EXE, which is the Paradise mode-setting routine. This allows setting the various display modes. The program also allows booting a disk from drive A:, presumably preserving the emulation state of the EGA. This did not work for the STYX program because low-resolution modes are not supported.

Sigma Designs, Inc. The half-length, C&T-based SigmaEGA! includes 256KB of video RAM. The feature connector and the RCA connector are present. The mode-setting switches can be accessed through the board bracket.

Installation is quite easy. The four standard mode-setting switches have to be configured. In addition, two jumpers, P1 and P3, need to be set. The manual lists the purpose of jumper P1 as determining monitor type—enhanced or not enhanced; P3 controls the board's base I/O address.

Packaged with the adapter is SIGMAEGA.COM, a RAM-resident program. This program provides a trapping-software approach to Hercules and CGA emulation. Under normal conditions it appears to run correctly.

The BIOS (version VX126+) and hardware passed all tests with ease. The BIOS contains the slow PC reboot bug, however, and the BIOS dot timings are mediocre at 38.4 seconds.

Sigma includes ZSoft's PC Paintbrush program with the SigmaEGA!. Also packaged with the adapter is a set of diagnostics. The manual that accompanies the adapter is clearly written.

Tseng Laboratories, Inc. Based on a proprietary ET2000 chip set, the EVA provides a superset of EGA functions. The ET2000, developed by Tseng, supports a number of different display modes heretofore unavailable on the EGA. The hardware supports 44 rows by 132 columns on an enhanced display. The chip set also can paint fonts up to 16 bits wide, as opposed to the standard 8 of the EGA. Vertical and horizontal zooming can be invoked anywhere on the screen from anywhere in the video RAM. With a zoom factor of 1, this can turn into a second graphics window apart from the standard EGA split screen. Zoom factors greater than 1 allow easy manipulation of pixels in graphics generator programs.

The ET2000 boasts a microsequencing feature, which boosts the speed of pixel modification, as in read-modify-write operations, by unloading the burden from the CPU onto the ALU (arithmetic logic unit) in the graphics controllers. When this mode is selected, it can increase pixel writing throughput. However, because special programming is required to use this mode, it is not really EGA compatible. For custom EGA applications, the microsequencing feature can vastly improve graphics performance.

The EVA itself is a full-length adapter card and comes with a parallel printer port that mounts on a stand-alone board bracket and is connected to the board by ribbon cable. Tseng populates the board with 256KB of video RAM. The board as reviewed has one jumper wire on its circuit side. It also has two jumper blocks and a bank of eight switches that control the configuration. The first four switches adhere to the EGA standard for board configuration. The remaining four control the BIOS size, amount of display RAM, and the parallel port. This information is clearly explained in the documentation.

The ET2000 chip set is a complete EGA implementation. Unlike Paradise's PEGA-1 chip, color graphics mode blinking works correctly. The ET2000 does not include some of the known IBM (and C&T) EGA hardware bugs. The first line of the split screen in high-resolution graphics modes is not duplicated. The cursor cannot be split across display rows as in the IBM EGA.

The different hardware results in minor incompatibilities. The documentation for the ET2000 states that access to the font during active display time causes visual interference. FantasyLand actively writes to the font plane during active display time, thus creating snow. Tseng states that this was a conscious decision; when the board is running in high-resolution modes—alphanumeric or graphics—the EVA splits every display RAM access evenly with the CPU, improving performance for video-RAM-intensive applications. Others limit the CPU to one access out five.

A $50 optional daughterboard provides emulation of the CGA, HGC, and monochrome adapter.

Tseng implements a trapping-hardware emulation scheme with its CM II compatibility module, which snaps in to the rear of the card. The CM II includes 11 chips altogether. The compatibility modes for HGC and CGA emulation can be controlled in a number of ways. Setting the four configuration switches to off will place the board, at power-up, in CGA emulation. With this feature, the user can directly boot game programs without using DOS. The EVA can boot up STYX and run Moonbugs and Centipede with no problem. The low-resolution Mandelbrot diagrams are displayed correctly. Software switching programs can control the emulation.

The software shipped with the board includes not only mode switching, but also an extended ANSI driver that knows about the board's 132-column modes. The documentation mentions a font editor and loader, but they were not available for this review.

Like so many other boards, the EVA has its share of BIOS errors. The save area routines do not function properly. The alternate print screen routines cannot handle 43-by-80 display modes correctly, because the BIOS never installs it in the correct interrupt vector. The BIOS erroneously posts the vector into the four bytes at segment 0000 offset 5H, which is not valid for any interrupt because all interrupt vectors begin at even addresses.

The statistics from the dot timing competition yield a dismal 40.3 seconds. This can be explained to some extent by tracing through the BIOS; all I/O instructions are byte OUTs rather than word OUTs. Unlike many boards, however, the EVA interprets the PC soft boot flag correctly. The EVA passed all CGA and HGC emulation tests.

Video7/Quadram. The VEGA from Video7, Inc. and the QuadEGA+ from Quadram Corporation are essentially identical and are treated as one board here. While the boards are available in both half- and full-card versions, the half-card version is reviewed. The board uses surface-mount technology, yielding a very compact layout. The only replaceable component is the ROM BIOS.

Configuring the board for installation is easy. The documentation is helpful in selecting the boot-up mode. A large toggle switch located on the board bracket determines the monitor type. Two jumpers are included. One controls the I/O base address, and the other allows the VEGA/QuadEGA+ to be installed in slot 8 of an XT.

The trapping-software emulation scheme seems to work very well. The program VEGA.COM (or QEGA.COM) installs as the RAM-resident emulation controller. The intercepts to the emulation handler occur via the NMI. Like all of the other trapping software boards, emulation fails in the game programs and the STYX bootability test. The Mandelbrot figures do not display correctly either. Hercules graphics emulation, however, works satisfactorily.

Because the board is a C&T implementation, the same hardware bugs present in the IBM EGA are present in the VEGA/QuadEGA+. It does not run the Sprites program for the EGA (see "Software Sprites," Michael Abrash and Dan Illowsky, August 1986, p. 125), indicating that the sense of the vertical retrace interrupt is reversed.

The reviewed VEGA has an early BIOS dated 12/10/85. The QuadEGA+ has a more recent version, 1.04, dated 2/10/86. The VEGA BIOS has errors in save area handling and in the alternate print screen routines. The PC reboot flag is interpreted incorrectly, forcing long reboots. The BIOS dot timing score is 29.5 seconds.

The BIOS of the QuadEGA+ corrects the save area routines and interrupt 42H pass-through, but the alternate print screen routines cannot handle 43-by-80 display mode. Its score on the BIOS dot timings is the same as the VEGA. As with the VEGA, PC reboots test all of memory and are slow.

Video7 and Quadram ship these boards with emulation software and a comprehensive set of diagnostics that are nearly the same as the IBM diagnostics for the EGA. The separate diagnostics manual contains a walk-through of the screens as they should appear during their operation.

The EGA portion of the board is complete in its implementation. The VEGA/QuadEGA+ passed all of the basic EGA tests. A $20 certificate for Microsoft Windows is enclosed.

VuTek, Inc. VuTek distributes an early version of NSI's EPIC full-card, described earlier. Called the E.G.A., this is a full-length board with 256KB of video RAM. Several bugs are present in both the hardware and the BIOS. When running EGATEST on the E.G.A., the system hung and had to be rebooted. The board is not able to put the alphanumeric page into the graphics page at address location A000H. Although this test is unusual, it is acceptable. Thus, many of the standard tests of EGA functions have to be inferred from the E.G.A.'s performance in other arenas.

The board runs DOS, hence most of the BIOS is correct. The BIOS passes on unrecognized video calls via a direct call to the motherboard BIOS rather than calling via interrupt 42H. The PC boot flag is incorrectly interpreted.

The FantasyLand test reveals several problems. The split screen pops up for an instant and subsequently disappears leaving a thick black line where the split screen ought to start. The scrolling and panning functions do not work at all. The 350th scan line is not displayed on either the monochrome or the enhanced display. In monochrome modes, the ninth dot extension for character graphics results in broken lines on graphics character boxes and forms.

VuTek packages the E.G.A. board with the same software that NSI sends with its EPIC full-card board.

TURBOCHARGED BOARDS

In addition to their standard EGA boards described above, both Orchid Technologies and Sigma Designs offer products that incorporate an accelerator card and an EGA on a single board. This combination offers users the opportunity to update their machines from the monochrome adapter or CGA and gain an EGA and accelerated performance in one expansion slot.

This article reviews these turbocharged boards for their EGA performance only. They will be reviewed again considering the accelerator performance in a future article.

Orchid Technology, Inc. Orchid couples a standard C&T chip set with an 80286 chip running at 6 MHz onto a full-length card to produce the Turbo EGA. The board comes with 256KB of video RAM. The EGA occupies half of the card while the other half supports the 80286 chip. All of the EGA pieces are there: the feature connector, light-pen pins, and RCA plugs. The board as reviewed has several jumper wires on its trace side. It also has space for an 80287 math coprocessor running at either 5 or

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The AST SixPakPremium expanded memory multifunction board has successfully passed compatibility testing with Symphony Release 1.1, and 1-2-3 Release 2 and Release 2.01 on an IBM Personal Computer using PC DOS 3.1. Two megabytes of expanded memory were installed.

8 Mhz. The Turbo EGA usurps the NMI, and the documentation instructs the user to disable the 8087's NMI by turning on switch 2 in switch block 1. Any 8087 errors while running in 8088 mode cause the system to hang.

The familiar EGA jumpers and switches are all included. The EGA jumpers control the monitor type and the I/O address. Several new jumpers control the configuration of the "turbo-charging" part of this board. Most chips are socketed. A board-level problem detected during the early phases of this review required changing one chip.

Installing the board is more complex than the usual EGA. The user has to place the system's 8088 chip in a new socket on the Turbo EGA and run a ribbon cable to the old 8088 socket. Errors could arise in positioning the 8088 chip because it is oriented backward from all of the other chips.

Most users will want to run the Turbo EGA in turbo mode where it provides the greatest performance. Microsoft's Windows and Word, both of which use BIOS calls for writing to the display, are quite fast in this mode. Apart from accelerated functions, all testing programs executed correctly.

Orchid includes a RAM-resident trapping software package in order to emulate the CGA, HGC, and monochrome adapter. The emulation appears to run correctly for both medium- and high-resolution graphics; low resolution is not supported, however.

The BIOS is very good. Even without the 80286, the dot timing test turns in a respectable 28.6 seconds. In turbo mode the BIOS timing for 65,000 pixel writes is 9.0 seconds, compared to 5.9 seconds for subroutine calls and 5.0 seconds for a direct in-line routine.

Like the other boards, the BIOS has a few small bugs in it. The alternate print screen routines do not know how to print 43 lines of text when the screen is in 43-by-80 mode. The save area routines are incorrectly written. Interrupt 42H pass-through, however, is correctly implemented.

Orchid packages the Turbo EGA board with a voucher for a free copy of Microsoft Windows.

Sigma Designs, Inc. Sigma's EGA/accelerator board, the TurboEGA!, is a full-length, C&T-based card that comes with a 10-MHz 80286. The boot-up mode leaves the 8088 in control. The 80286 is given control from a DOS command line utility. The TurboEGA! has a full complement of 256KB of video RAM and, in addition, 4KB of 16-bit cache RAM for the 80286. The feature connector is present but the RCA jacks are not. The board bracket for the adapter contains the monitor connector as well as a reset button.

Installing the board is simple. The documentation clearly defines the steps to integrate this complicated board into a system. Sigma had the foresight to include a chip-lifting tool for relocating the 8088 onto the adapter. The EGA configuration is readily accomplished with the guidance of the manual.

One flaw in the documentation involves port remapping in turbo mode. The turbo activation port's I/O address can be relocated by two jumpers on the card, circumventing possible I/O address conflicts with other devices on the system. The README file is the only source of information regarding the port relocation, and its summary of jumper settings versus port addresses is incorrect. With the jumpers in place to readdress the hardware, readdressing the mode-changing software is accomplished through a command-line parameter when the software is installed. Exiting turbo mode requires rebooting the system; if not, the computer behaves unpredictably—in two cases during testing the screen went dead, and DOS complained that the file allocation table was bad. In both instances, a reboot fixed the apparent problem without any damage to the system.

The EGA portion of this card is the same as the SigmaEGA! reviewed above. The board ran all programs of the test bed flawlessly. EGATEST was passed easily. The trapping-software emulation included CGA and HGC, but not the monochrome adapter. CGA low-resolution graphics mode is not supported.

The BIOS for TurboEGA! is the same as the SigmaEGA!. The only detectable BIOS error encountered is misinterpretation of the warm reboot flag in the PC. Curiously, the 65,000-pixel painting statistics are unusual in turbo mode. The direct subroutine calls and the in-line code test ran in 5.4 seconds. In turbo mode, the BIOS calls are very slow at 40 seconds. The BIOS time for the 8088 mode is 44 seconds. Constant arbitration between the 8088 and 80286 for control of the ROM BIOS nullifies the 80286's speed advantage in executing ROM-based code.

EMULATION AND COMPATIBILITY

Judging from the performance of the boards reviewed here, achieving complete EGA compatibility and emulating other adapters on the same board is a difficult task. With two exceptions, the advanced implementations that claim

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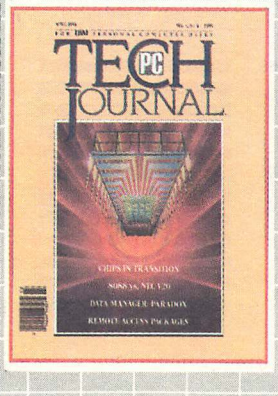

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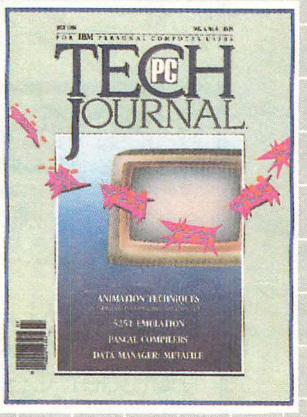

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CGA, HGC, or monochrome emulation do not emulate all features of the earlier boards. The two adapters that do provide complete emulation of the other displays, the NSI EPIC half-card and VuTek E.G.A., themselves are short of being true EGAs.

The potential user of these boards must analyze what emulation will buy—and at what cost. The trapping-software technique is slow and can conflict with operation of the 8087 coprocessor through preemption of the NMI. Trapping hardware is faster, but costs more. The complete hardware solution to emulation falls short of supporting all functions of the true EGA.

In the long run the user may be better off updating program code and changing to commercial applications fully supporting the EGA or using older modes only in a well-behaved manner. The single-chip EGA designs mean that display adapters soon will be incorporated into the CPU motherboard. While future generations of graphics adapters may well emulate the EGA, whether they emulate the earlier boards as well is very much an open question.

All of the boards presented here perform adequately for EGA functions. One clearly outshines the others: Tseng's EVA. The Tseng chip set correctly implements all EGA functions, and its BIOS problems are minor. All modes of emulation are provided even at boot-up of the system.

The augmented functions to the IBM EGA run only on an EVA board, but should be of interest to programmers of performance-sensitive graphics applications in which the hardware can be specified. The quality of documentation, completeness of implementation, and augmented chip set make this adapter a good choice.

John T. Cockerham, M.D., is a cardiologist at The Children's Hospital in Boston and is on the faculty of Harvard Medical School.

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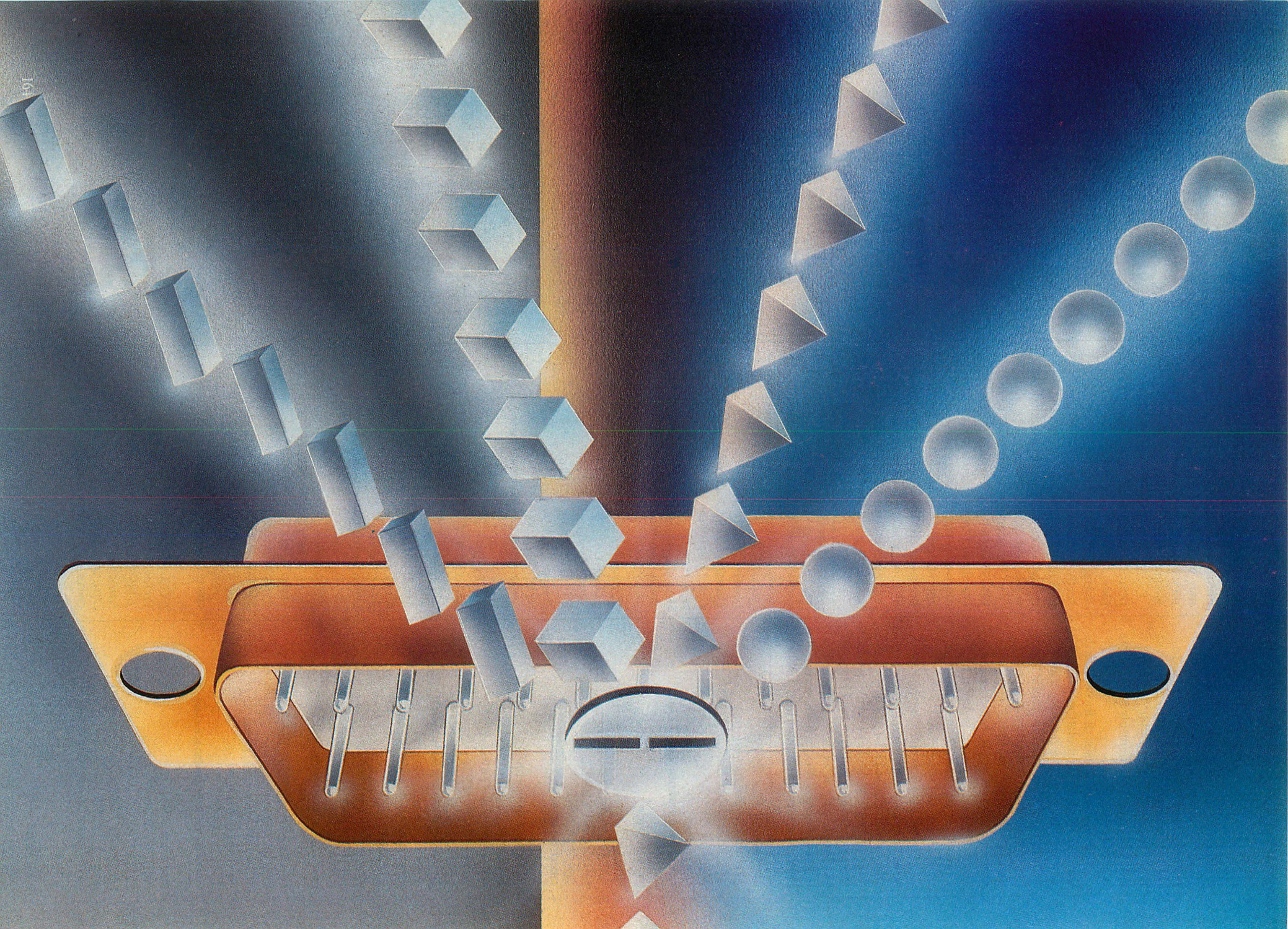

UNIX Serial Device Filters

Access to peripheral devices should be controlled using standard techniques on a UNIX-based multiuser system.

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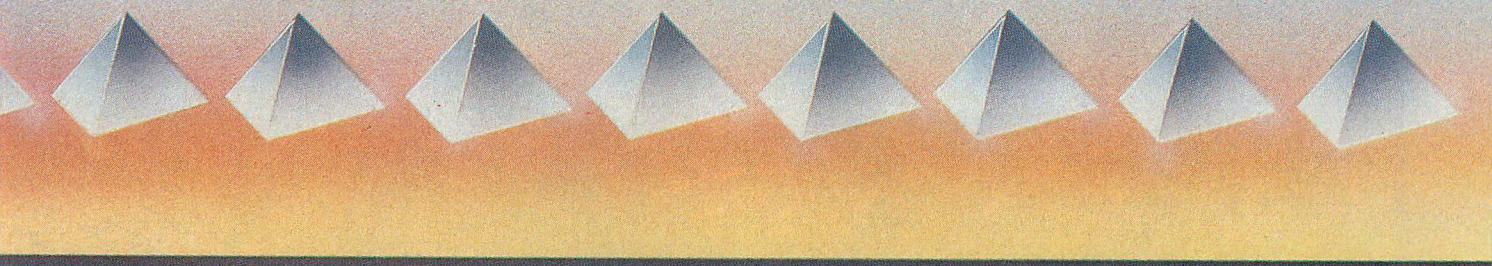

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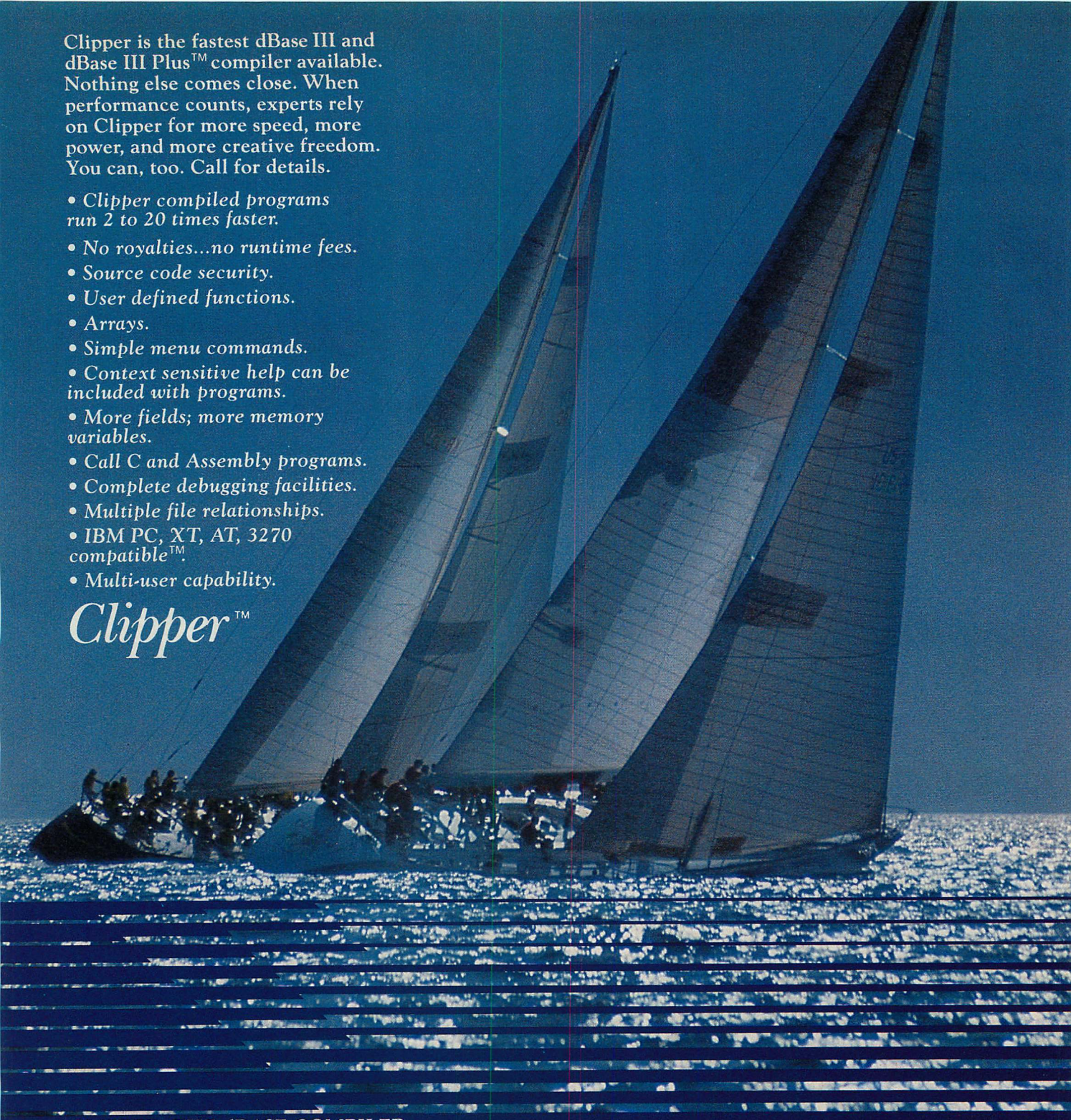
Although DOS has borrowed many of its features from the UNIX operating system; UNIX still holds significant surprises for programmers who are accustomed to writing for DOS. Multiuser UNIX systems, for example, must prevent more than one process from accessing the same serial device at one time. This article discusses several methods to control access to serial devices under UNIX.

DOS presents very few constraints to prevent a program from opening a serial port and pumping out data to a plotter or printer; from storing data at a particular place in memory by using a Pascal address type or by assigning a value to a pointer in C; or from writing directly to the screen buffer to make fast menu displays or optimized graphics for a game. The worst that can happen is that during debugging one of the pointers will go astray, the machine will lock up, and the programmer will have to resort to rebooting. The crash might be annoying and the problem may be tricky to track down, but only the programmer will suffer the consequences.

By contrast, in a multiuser, multitasking system such as Microsoft's XENIX, the operating system must prevent a misplaced pointer or misdirected output from interfering with another process or bringing down the system. (XENIX is Microsoft's version of the UNIX operating system; the material in this article is equally applicable to most of the other UNIX systems.) To guarantee its own integrity, the operating system puts constraints on user programs: for example, such a program cannot make calls to the system-monopolizing ROM BIOS, and the program must make a proper request of the operating system for whatever memory it needs. To the extent that it is available, the operating system will allocate memory to meet the request.

The program does not know where the allocated memory will be and cannot depend upon a particular location. In the course of swapping programs in and out of memory, the kernel may put data or text in one address at one point in the execution of the program and in another address at another point. If a program attempts to address memory that has not been allocated to that program, a "Segmentation violation" or "Memory fault" message will be gener-



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ated. On a PC/AT running XENIX, this memory management is handled by the iAPX286 chip in protected mode.

MANAGING SERIAL LINES

Because the peripheral devices on a multiuser system are shared among users and processes, a program cannot blindly send output to peripheral devices. A device, like any other XENIX file, has separate read, write, and execute permissions for the owner of the file, users in the owner's group, and all other users on the system for a total of nine permissions. These permissions can be changed by the owner of the file. For a device, only the read and write permissions are relevant. The superuser, or *bin* (a pseudo-user who is the "owner" of system resources in many UNIX systems) can change the read and write permissions of devices to limit their use to a particular user or group of users.

The ownership of the diskette drives or a dedicated serial line can be changed to *asg*, and the **assign** command can be invoked to limit use of the device. The user to whom a device is assigned is the effective owner and has exclusive control over the device. The problem with this mechanism is that many small XENIX systems, such as the AT, have a limited number of serial lines (the AT is configured with only two lines in addition to the console). Lines often have to be shared between devices or uses. For example, a line might be switched among plotter, serial printer, and terminal, either by using an A/B switch or by swapping cables. Alternatively, a line could be connected to a modem and used both for log-ins by users on remote terminals and for communications by **cu**, **uucp**, **C-kermit**, or another communications program. Lines that are used for log-ins cannot have restricted permissions and therefore cannot be assigned.

Before a log-in line can be used for a serial device or for outgoing calls through a modem, it must be *disabled* (removed from multiuser status). XENIX includes a command, **enable/disable**, that allows the superuser to control whether a given serial line is enabled for multiuser log-ins. The command works by rewriting the file **/etc/ttys** so that a *1* is used as the first character of the entry for a serial line that is to be enabled, and a *0* is the first character of an entry for a line that is to be disabled. (Serial lines in UNIX are generally called **/dev/tty??**.) **Enable/disable** then sends a SIGINT signal to the system process **init**, causing **init** to read **/etc/ttys** and fork (create a new process) and execute **getty** and **login** as it is necessary.

For systems that do not have the **enable/disable** command, the code shown in listing 1 should work on any UNIX system that uses an **/etc/ttys** file. For regular use, the code can be refined to examine **/etc/utmp** (the file UNIX and XENIX use to keep track of active log-ins) or to use **popen()** on the **who** command to see if the line is in use. (The **popen()** function creates a pipe that directs the output of the **who** command to the calling program.)

Enable/disable is a powerful command. Misuse of the command or sloppy code in programs that call basic system processes such as **init** is an invitation to trouble. The code in listing 1 traps every signal from the system except SIGKILL before the call to **init**. It does so to prevent accidental destruction of **/etc/ttys**, which would leave the system without a list of user terminals for the next boot-up. **Init** should not be invoked repeatedly in rapid succession, which could eliminate process 1 (**init** itself) and bring down the system. To prevent such a disaster, use of the **enable/disable** command is generally restricted to the superuser.

Because the peripheral devices on multiuser systems are shared among users and processes, a program cannot blindly send output to peripheral devices.

An alternative procedure is to use the **setuid** bit. Setting this bit in the permissions of an executable file allows other users of the command to take on temporarily the privileges of the owner, in this case the superuser. A shell script also can be used to invoke a restricted version of the command under the name **attach/detach**. The temptation is to make the shell script **setuid**, which would protect the raw command from misuse; unfortunately, XENIX shell scripts ignore the **setuid** bit. Whatever the permissions that are assigned to **enable/disable**, the users should be warned not to reinvoke the command for a full minute, to avoid bringing down the system.

Once a line is disabled and can be used by a printer or plotter, or when a dedicated line is available for a system peripheral, the housekeeping is still not finished. In most cases, the system sets locks on peripheral devices. For example, the **lpr** printer command creates the file **/usr/spool/lpd/lock** when it is invoked. A subsequent invocation of the command by any user will make note of the lock and put the files into the print spooler. Similarly, the UNIX communications programs **uucp** and **C-kermit** both set a lock in **/usr/spool/uucp** when they take charge of a serial line for call-out. (The **cu** communications utility should set a lock, but in the version of XENIX III distributed by IBM for the AT, it does not; it only notes a lock set by another program.) These locks prevent two users from calling out on a modem over the same line; the dialing string on the second call would go out with unpredictable results over the serial line.

Such problems can be avoided without locks, although the methods are not as effective. For example, the commands **who** (which lists users who are logged in) or **ps** (which lists active processes) can be invoked, but they require the user to check the lines. This is not a secure enough precaution for regular use within a multiuser environment. A program also can be created to guarantee the exclusive use of a serial device by setting the XCLUDE bit in the **c_lflag** of structure **termio**, the control structure for serial device interfaces, when the line is conditioned by **ioctl()**. However, if the XCLUDE bit is not cleared before the program terminates, subsequent attempts to open the device by anyone other than the superuser will fail and return EBUSY in **errno**. Setting locks is much less ambiguous and allows programs to return more specific error messages.

Besides checking for and placing locks, programs that use system peripherals must make certain that all locks are cleared when the program terminates. Otherwise a subsequent effort to plot or to use the line for another purpose will abort because of the lock. In some cases, only the superuser or the owner can clear a lock. This is a particular problem when a lock is inadvertently left on a serial line, and the system later attempts unattended file transfers with **uucp** or **C-kermit**. Both programs report a "line not available" message if they find a lock on the line.

Fortunately, none of this housekeeping is difficult or complex. The XENIX system has many built-in facili-

ties that make the configuration and use of the serial lines relatively simple. The functions to set the speed, parity, and other line parameters, as well as the flow control and specialized character handling (such as mapping carriage returns to line feeds), are available in the standard C library.

A SIMPLE FILTER

A UNIX program that reads input from a file, transforms it, and writes the result as output is called a *filter*. The code in listing 2 is for a simple serial device filter for a Hewlett-Packard 7470A plotter. The filter performs the following functions:

1. It checks the specified or default serial line to see if the line is available.
2. It checks whether a lock exists on the line. If there is not, it places its own lock on the line.
3. It conditions the line for the "handshake" required by the plotter.
4. It polls to see if the plotter is ready.
5. It parses command line options, such as a title or user-specified maximum and minimum plotting points.
6. It reads either a series of commands in HP-GL, Hewlett-Packard's standardized plotter language, or a series of ASCII-formatted or *xy* values;
7. When the plot is finished, it polls the plotter to see if an invalid instruction or an RS-232 error has occurred.
8. It clears every lock to allow subsequent use of the line by another peripheral device.

Modifying the program to serve as a filter for a printer or another serial device only requires changing the definitions of initialization strings and the responses read from the device. In keeping with UNIX tradition, the filter accepts input from a pipe or a file.

Because the filter generally will be used in a pipe of commands, options are not specified through menus or other interactive command parsing. Instead, they are specified on the command line in this form:

plotter {options} {input file}

The available options include:

-t	Specifies points scaled to a Tektronix display (4,096 by 3,120 pixels)
-p	Reads **xmin**, **ymin**, **xmax**, and **ymax** scaling points from the first line of input
-l title	Specifies left-justified title
-c title	Specifies centered title
-d device	Specifies an output device (**tty00** is the default)

These options are probably sufficient for most uses of the filter. Other

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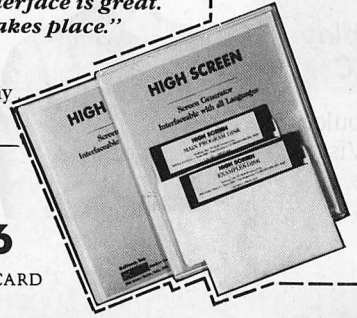

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options, such as a subtitle or a date stamp, can be added of course, but, in general, to avoid rereading "usage" statements, the options of any program should be kept fairly simple. The options always can be enhanced through the use of shell programming.

Complex plotter instructions from a GKS or other graphics program will probably be in HP-GL language, and they can be piped directly to the plotter through the filter:

```
gksmkplot myplot | plotter -dtty01
```

In this case, device **tty01** has been specified instead of the default device.

If a series of points or HP-GL instructions are stored in a file, the program can read the file instead of the standard input:

```
plotter -pl "Fractal Dragon" my.dragon
```

The **-p** specifies that the list of points is prefaced by scaling points (the first four points of the input are **xmin**, **ymin**, **xmax**, and **ymax**); the **l** specifies a left-justified title. The name of the file follows the option specifications and is not prefaced by a hyphen. (XENIX and UNIX are much less restrictive than DOS in naming files; a name can be up to 14 characters long, periods can be used anywhere in the name any number of times, and case is significant.)

FILTER FUNCTIONS

The function **scanarg( )** uses the C library function **getopt( )** to parse the command line. **Getopt( )** requires that options be specified by single letters preceded by a hyphen, allows options that expect arguments to have optional white space before the argument, and permits options that do not require arguments to be clustered. These specifications are gradually becoming the standard in UNIX, which may help to bring some order to the chaos of command line parsing.

After the command line is scanned, function **do_lock( )** first parses the device name, which the user may have specified in long or short format (**/dev/tty01** or **tty01**), and then checks for a corresponding lock in directory **/usr/spool/uucp**. The locks left by **uucp** and **C-kermit** are files with names in the format **LCK..cul?**. In a small UNIX system, a **cul?** device is usually a link to a **tty** line. If the program is able to find either **LCK..cul?** or **LCK..tty??**, it exits with a message. If the program does not locate them, it then puts its own lock into the file. The **perror( )** system function is used to report if and why a lock cannot be created.

Once a lock has been set, the program must trap every possible signal from the system to make certain that the lock is cleared before the program exits. The three invocations of **signal( )** trap exits resulting from the user's pressing DEL, quit (Ctrl-\), or the alarm function. The function **die( )** makes certain that the lock is removed before the program exits.

If the line is available and the lock is in place, the program attempts to open the line to obtain a file descriptor (**fd**). If the line cannot be opened—for example, if the line, though not locked, is enabled for a terminal or modem—the open call fails (return **-1**), **perror( )** gives an appropriate message ("Permission denied"), and the program clears its lock and exits.

If the line can be opened, function **setline( )** uses **ioctl( )** to condition the line to the appropriate parameters—in this case, 9600 baud, CLOCAL (direct line without modem control), ICRNL (incoming CR mapped to NL), and IXON (XON/XOFF enabled). The line parameters are easily changed with the C operators |, &, and ~ (bitwise *or* and *and* and unary 1's complement); the mnemonics from the various standard UNIX header files are to a certain extent less obscure than the octal numbers that they represent.

The line is then opened with separate file pointers (***plw** and ***plr**) for writing to and reading from the plotter, and the function **setbuf( )** is used to set unbuffered output.

The rest of function **main( )** initializes the plotter with various set-up strings. It also checks to see if the plotter is ready by querying and reading its status before outputting any data. The set-up strings specify the XON/XOFF characters and the size of the buffer in the plotter. Most serial devices require adjustments to the buffer sizes and to other parameters before the device's operation is completely reliable.

Depending upon the command line specifications, the program then reads a series of points or lines of HP-GL commands until it reaches the end of the input file or pipe or an EOF indicating the end of input from the terminal. If **-p** has been specified on the command line, the first four points are read as minimum and maximum plotting points, and the scaling is adjusted accordingly. The ERR( ) macro is used here and elsewhere in the program to report error conditions such as invalid scaling points. For a filter such as this one, which is generally used in a pipe of several commands, an error-reporting macro or function should include the name of the program.

When the plot is finished, the filter polls the plotter to see if an HP-GL or RS-232 error has occurred. Most serial devices will have comparable error checking for problems such as overflowing an input buffer or receipt of an unrecognizable printer code. The alarm signal prevents the filter from hanging indefinitely if it does not get an answer from the plotter. Finally, the **die( )** function is called to ensure the lock is cleared before the program exits.

This sample program is used by only one user, so it does not have to be compiled with separate instruction and data space. On an active system, the filter should be placed in the **/usr/lbin** directory most systems have for local commands and that most users have in their default command paths. This makes the convenience of the plotter available to system users.

Ronald Florence is a self-confessed UNIX addict. He is the author of The Optimum Sailboat *(Harper & Row, 1986).*

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LISTING 1: ENABLE.C

```
/*
 *  enable.c  copyright 1986 Maple Lawn Farm, Inc.
 *  drops/adds terminals from/to multi-user status
 *  usage: "enable ttyxx"  or  "disable ttyxx"
 *  compile:  cc -O -s -o enable enable.c
 *            ln enable disable
 */
#include <stdio.h>
#include <signal.h>
#define LEN     40
#define INIT    1                       /* init is pid 1 */
#define TTYS    "/etc/ttys"
#define TMP     "/etc/ttys.tmpXXXXXX"
char    *mktemp();
main(argc, argv)
int  argc;
char **argv;
{
        char    **p, buf[LEN], *last,
            *tmp = mktemp(TMP),
            set = (**argv=='d') ? '0': '1';
        int     i, change = 0;
        static  int     (*sigs[NSIG-1])();
        if (!freopen(TTYS, "r", stdin))
                perror(TTYS), exit(1);
        if (!freopen(tmp, "w", stdout))
                perror(tmp), exit(1);
        while (fgets(buf, sizeof buf, stdin)) {
                                /* use last char as tty id */
                last = buf + strlen(buf) - 1;
                *last = '\0';
                                /* check argv for match */
                for (p = argv+1; *p; ++p)
                        if (**p && !strcmp(last-strlen(*p), *p))
                                break;
                                /* check status in file */
                if (*p && buf[0] != set) {
                        ++change;
                        buf[0] = set;
                }
                puts(buf);
        }
        if (change) {
                                /* trap all interrupts */
                for (i=1; i<NSIG; ++i)
                        if (i != SIGKILL)
                                sigs[i-1] = signal(i, SIG_IGN);
                fflush(stdout);
                                /* you're committed now */
                rename(TTYS, tmp);
                                /* make init reread TTYS */
                if (kill(INIT, SIGINT) == -1)
                        perror("init");
                                /* let life go on */
                fputs("Please do not enable/disable for one minute.\n",
                        stderr);
                for (i=1; i<NSIG; ++i)
                        if (i != SIGKILL)
                                signal(i, sigs[i-1]);
                exit(1);
        }
        else {
                fputs("no change to /etc/ttys\n", stderr);
                unlink(tmp);
        }
}


rename(new,old)
char  *new, *old;
{
        unlink(new);
        if (link(old, new) == -1)
                perror(new), exit(1);
        if (unlink(old) == -1)
                perror(old), exit(1);
}
```

LISTING 2: PLOTTER.C

```
/*
 *  plotter.c   output driver for HP7470A plotter
 *  copyright 1986 Maple Lawn Farm, Inc.
 *  options:
 *  -t          reads points scaled to Tektronix (4096x3120)
 *  -p          reads xmin,ymin,xmax,ymax scaling points from input
 *  -l title    left-justified title
 *  -c title    centered title
 *  -d dev      specifies output device (tty00 is default)
 *  compile:  cc -O -s -o plotter plotter.c
 */
#include <stdio.h>
#include <fcntl.h>
#include <sys/ioctl.h>
#include <sys/types.h>
#include <termio.h>
#include <signal.h>
#define CENTER  02
#define SCALED  04
#define TEK     01
#define BAUD    B9600
#define HPXON   "\033.180;;17:"         /* 80 char buffer, xon char */
#define HPXOFF  "\033.N;19:"            /* xoff char */
#define HPSTAT  "\033.O"
#define HPABORT "\033.K"
#define HPRSERR "\033.E"
#define LOCK    "/usr/spool/uucp/LCK.."
#define USAGE   "usage: %s [-tp] [-d device] [-c | -l title]\n"
#define ERR(a,b)        fprintf(stderr, "%s: ", prognm),\
                        fprintf(stderr, a, b)
char    *title, *prognm,
        *plotdev = "/dev/tty00",        /* default device */
        lock[sizeof(LOCK) + 5] = LOCK;
FILE    *plr, *plw,
        *fi = stdin;
int     hflag,                          /* heading flag */
        pflag,                          /* points, not HP-GL */
        die(), quit();
```

```
main(argc, argv)
int  argc;
char **argv;
{
        int     fd, hperr, alrmint();
        char    buf[BUFSIZ];
        prognm = *argv;
        scanarg(argc, argv);
                                        /* check/make lock */
        do_lock();
                                        /* trap exits */
        signal(SIGQUIT, die);
        signal(SIGINT, die);
        signal(SIGALRM, alrmint);
                                        /* line OK? */
        if ((fd=open(plotdev, O_RDWR|O_NDELAY)) < 0 )
                perror(plotdev), die();
                                        /* set line & handshake */
        setline(fd);
        fputs(HPXON, plw);
        fputs(HPXOFF, plw);
                                        /* check plotter */
        alarm(5);
        do {
                hperr = readhp(HPSTAT);
        } while (hperr < 0 || hperr > 40);
        if (hperr > 8)
                ERR("not ready\n", NULL);
        alarm(0);
                                        /* make sure we clean up */
        signal(SIGINT, quit);
                                        /* initialize plotter */
        fputs("in;", plw);
        if (hflag)
                heading(title);
                                        /* pen 1 */
        fputs("sp1;", plw);
                                        /* xy points ? */
        if (pflag)
                points();
```

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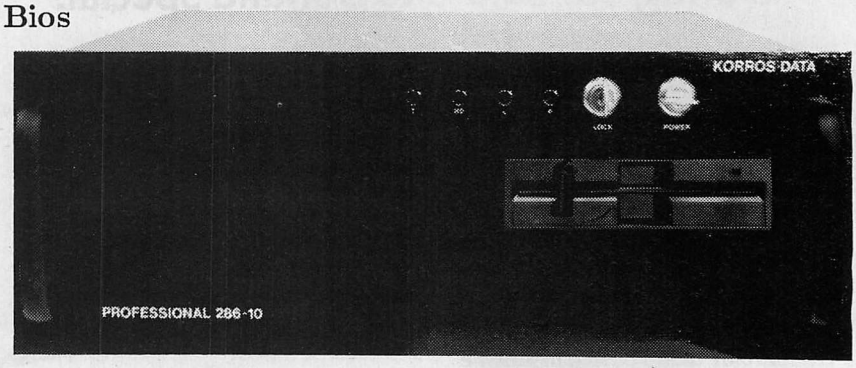

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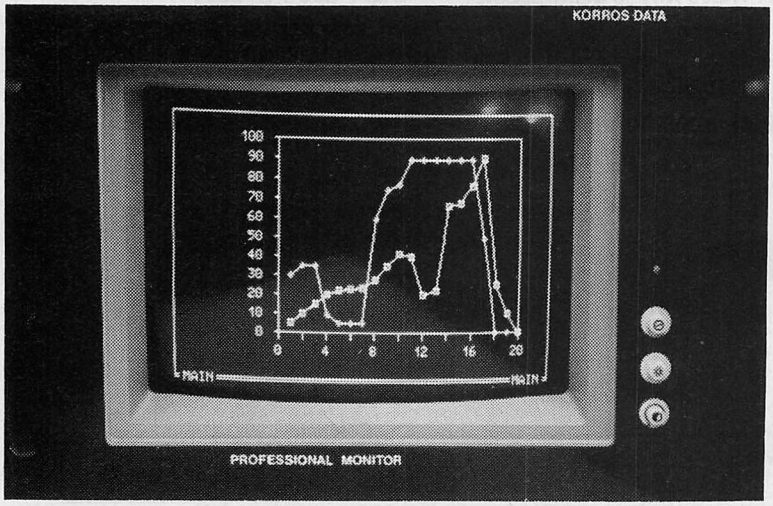

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```
                                        /* HP-GL instructions */
        else
                while (fgets(buf, sizeof buf, fi) != NULL)
                        fputs(buf, plw);
                                        /* check for errors */
        alarm(60);
        if ((hperr = readhp("OE;")))
                ERR("HP-GL error = %d\n", hperr);
        if ((hperr = readhp(HPRSERR)))
                ERR("rs232 error = %d\n", hperr);
        alarm(0);
                                        /* pen home, unlock */
        fputs("sp0;", plw);
        die();
}
heading(title)
char  *title;
{
        int     tx, ty;
                                        /* fix location of title */
        ty = 7350;
        tx = (hflag & CENTER) ? 5150 : 500;
                                        /* pen 2, char size */
        fprintf(plw, "sp2;si.30,.48;pu%d,%d;", tx, ty);
        if (hflag & CENTER)
                fprintf(plw, "cp -%d,0;", strlen(title)/2);
        fprintf(plw, "lb%s\003", title);
}
points()
{
        int     first=0;
        double  x, y, ipx1,
                xmin = 0.0,             /* default tektronix scaling */
                ymin = 0.0,
                xmax = 4096.0,
                ymax = 3120.0;
                                        /* need scaling points? */
        if (pflag & SCALED)  {
                if (fscanf(fi, "%f%f%f%f",
                        &xmin, &ymin, &xmax, &ymax) == EOF)
                        quit();
                if (xmin >= xmax || ymin >= ymax)
                        ERR("invalid scaling points", NULL), quit();
        }
                                        /* get aspect ratio
                                         * set new p1  */
        ipx1 = 10250 - (7200 * (xmax-xmin)/(ymax-ymin));
        fprintf(plw, "ip %.f,279,10250,7479;", ipx1);

                                        /* scale to user units */
        fprintf(plw, "sc %.f,%.f,%.f,%.f;",
                        xmin, xmax, ymin, ymax);
                                        /* read and output points */
        while (fscanf(fi, "%f%f", &x, &y) != EOF)
                fprintf(plw,(++first==1) ?\
                        "pu%.4f,%.4f;pd" : "%.4f,%.4f ",x,y);
        fputs("pu;", plw);
}
alrmint()
{
        ERR("no response\n", NULL);
        die();
}
die()
{
        if (unlink(lock) == -1)
                perror(lock);
        exit(0);
}
quit()
{
        fputs(HPABORT, plw);
        fputs(" sp0;", plw);
        die();
}
scanarg(argc, argv)
int  argc;
char **argv;
{
        extern  int     optind;
        extern  char    *optarg;
```

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```
        int     i;
        while ((i = getopt(argc, argv, "d:tpc:l:h?")) != EOF)
                switch (i)  {
                case 'd' :              /* device specified */
                        strcpy(plotdev, optarg);
                        break;
                case 'p' :              /* scaling points */
                        pflag |= SCALED;
                        break;
                case 't' :              /* tektronix points */
                        pflag |= TEK;
                        break;
                case 'c' :              /* centered title */
                        hflag |= CENTER;
                case 'l' :              /* left-justified */
                        hflag |= 01;
                        title = optarg;
                        break;
                case 'h' :
                case '?' :
                        fprintf(stderr, USAGE, progmm), exit(1);
                }
        if (argc > 1 && argc != optind)
                if ((fi=fopen(argv[optind], "r")) == NULL)
                        ERR("cannot find %s\n",
                                argv[optind]), exit(1);
}
setline(fd)
int  fd;
{
        struct termio term;
        ioctl(fd, TCGETA, &term);
        term.c_cflag &= ~CBAUD;
        term.c_cflag |= BAUD|CLOCAL;
        term.c_lflag &= ~ECHO;
        term.c_iflag |= ICRNL|IXON;
        term.c_cc[VMIN] = 1;
        term.c_cc[VTIME] = 0;
                                /* drain output
                                 * flush input queue
                                 */
        ioctl(fd, TCSETAF, &term);
        if(!(plr=fopen(plotdev,"r")) || !(plw=fopen(plotdev,"w")))
                die();
                                /* unbuffered output */
        setbuf(plw,0);
}
readhp(query)
char  *query;
{
        int  hperr;
        fputs(query, plw);
        if (fscanf(plr, "%d", &hperr) == EOF)
                die();
        return(hperr);
}
do_lock()
{
                                /* alternate lock */
        char    *cu = "/usr/spool/uucp/LCK..cul ",
                dvc[5], *strchr();
        int     ld;
                                /* parse device name */
        if (strncmp(plotdev, "/dev/", 5))  {
                strcpy(dvc, plotdev);
                strcpy(plotdev, "/dev/");
                strcat(plotdev, dvc);
        }
        else
                strcpy(dvc, strchr(plotdev, 't'));
                                /* setup lock file names */
        strcat(lock, dvc);
        cu[strlen(cu) -1] = dvc[strlen(dvc) -1];
                                /* check for locks */
        if (!access(lock,0) || !access(cu,0))
                ERR("%s is locked\n", dvc), exit(1);
                                /* create a lock */
        if ((ld = creat(lock, 0644)) < 0)
                perror(lock), exit(1);
        close(ld);
}
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CIRCLE NO. 117 ON READER SERVICE CARD

"How to protect your software by letting people copy it."

By Dick Erett, President of Software Security

Inventor and entrepreneur, Dick Erett, explains his company's view on the protection of intellectual property.

"A crucial point that even sophisticated software development companies and the trade press seem to be missing or ignoring is this:

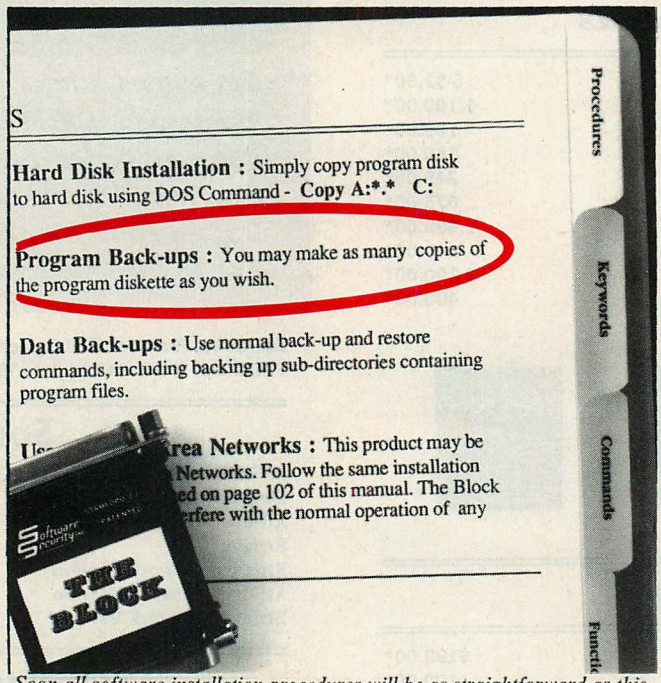
Software protection must be understood to be a distinctively different concept from that commonly referred to as copy protection.

Fundamentally, software protection involves devising a method that prevents unauthorized use of a program, without restricting a legitimate user from making any number of additional copies or preventing program operation via hard disk or LANs.

Logic dictates that magnetic media can no more protect itself from misuse than a padlock can lock itself.

Software protection must reside outside the actual storage media. The technique can then be made as tamper proof as deemed necessary. If one is clever enough, patent law can be brought to bear on the method.

Software protection is at a crossroads and the choices are clear. You can give product away to a segment of the market, or take a stand against the theft of your intellectual property.



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CIRCLE NO. 189 ON READER SERVICE CARD

BURKS A. SMITH

Determining Free Disk Space

An assembly language routine can be called from BASIC to let the user know the amount of free space that exists on a disk.

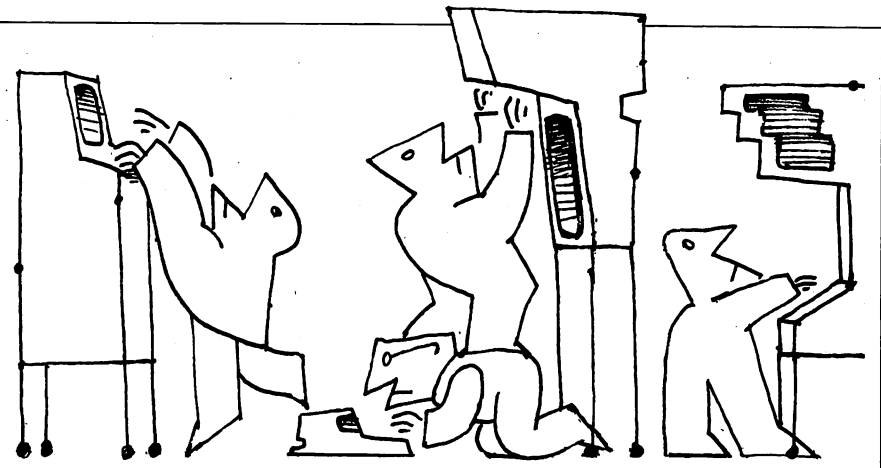


ILLUSTRATION • MACIEK ALBRECHT

PC BASIC has no built-in feature that tells the user how much unused space remains on a disk. Such a feature is certainly desirable to avoid having a program end with a "disk full" error. If an application program knew the available space and how much data were about to be written to the disk, it could prompt the user to insert a fresh diskette if necessary.

With DOS 2.0, a new function (36H) was added to the service routines that indicates the amount of free space on a disk. A simple assembly language procedure can be called from BASIC to obtain this information.

FSPACE.BAS (listing 1) is a BASIC program illustrating the use of this routine. Because the machine code is short, it can be included in the application program in DATA statements and read into memory via a string variable.

The subroutine at line 500 initializes the program by determining whether the interpreter or compiler is being used and fills the variable FS$ with the machine code contained in data statements. Determining whether interpreted or compiled code is in use is important because they call machine language routines differently.

In interpreted BASIC the address of the string descriptor that is returned by VARPTR is stored in a different format than with the compiled version. The length of the string is stored in one byte in interpreted BASIC and in two bytes by the compiler. The syntax for the CALL statement also is different in compiled and interpreted BASIC. The program takes advantage of the fact that the interpreter stores the number of the current line being executed at offset 2EH into BASIC's data segment (as documented in the *Technical Reference* for the PC/XT and the PC/AT). Therefore, if that address contains the number of the line doing the checking (line 530 in the example), the program is being run in the interpreter.

Two possible pitfalls exist in using this technique. First, if the line numbers in the program are changed, the comparison line (line 530 in the example) also needs to be changed. CMPL% = NOT(A=530) has to be manually edited, changing 530 to the correct line number, or the routine will think that the compiler is being used, and the program will surely crash. Second, the program depends on the fact that the interpreter's line number storage address will not contain the line number when using the compiler. Actually, there is a small chance (65,536 to 1) that it will by coincidence and cause an error. If this does occur, it can be cured simply by changing the line number constant and recompiling the program. Note that this coincidence will occur when the program is first run or not at all. It does not vary each time.

Lines 550 and 560 fill the string variable FS$ with the machine code by reading each data element and appending its single byte character representation to the string. The last data element, /*, is used to represent the end of the code; it terminates the process.

The subroutine at line 1,000 actually calls the routine. It expects the variable PTH$ to contain a valid data path or a drive letter, and the CMPL% flag to be set "true" if the program is compiled or "zero" if the program is being run in the interpreter. The VARPTR function returns the address of a "string descriptor," which has a somewhat different format for the interpreter and compiler. The first two bytes (one for the interpreter) contain the length of the string. The next two contain the address of the string in memory, which will be the execution address for the subroutine stored there. In lines 1,030 and 1,040, this address is extracted according to the compile flag, CMPL%, and placed in the variable FS.

Line 1,050 makes FS an integer value, FS%, so that if the address is greater than 32KB the value appears negative. For example, if the address is FFFFH, FS% will appear as an integer representation, -1. This is necessary because the compiler treats the address as an unsigned 16-bit value. Note that the address of the string FS$ always must be determined immediately before making the call, because BASIC may rearrange string storage periodically and the address could change.

In the example, line 130 assigns a null value to PTH$. This value should be changed if the free space for a specific drive rather than just the default drive is required for the relevant appli-

cation. The DOS free space function requires the drive to be expressed as a number, where 0 is the default drive, A:=1, B:=2, etc. Lines 1,060 and 1,070 search the path string, PTH$, for a colon that would indicate that the path had a drive designator. If found, the letter just to the left of the colon is converted to a number as required. If no colon is found, the default drive is assumed and the drive designator is 0. Everything else, including directory paths, in PTH$ is ignored.

For interpreted programs the calling syntax is CALL address (arguments), while the compiler uses CALL ABSOLUTE (arguments, address). The program includes both variations, and uses one or the other depending on the value of CMPL% in lines 1,090 and 1,100. If the BASIC programs are compiled, the linker complains that the reference to FS in line 1,090 is an "undefined external," but this is only a warning error. Line 1,090 will never be executed in a compiled program.

FSPACE.ASM (listing 2) is an assembly language listing of the actual subroutine. As with all machine language routines that are CALLed from BASIC, it is a FAR procedure, which means that both the segment address and segment offset are pushed on the stack for the purposes of returning. It is impossible to know where the routine will reside in memory, so it has been coded without references to absolute addresses and uses only SHORT jumps, which are relative to the instruction pointer rather than to an absolute location. This allows the program to be located anywhere in memory and still work.

When the subroutine gains control, the addresses of the arguments are buried on the stack, so its first task is to move the location of the stack pointer to the BP register allowing data in the stack to be accessed. Next, the routine makes a DOS call to determine the version of DOS being used. If it is version 1.0, the disk free space function is not available so the program just forces the free space to -1 to indicate this fact. The calling program then proceeds without benefit of knowing the free space.

Once the routine determines that DOS 2.0 or later is installed, it extracts the drive designator from the stack and makes a function 36H call to determine the amount of free space on disk. Three numbers are returned: BX has the number of available clusters on the disk; AX has the number of sectors per cluster; and CX has the number of bytes per sector. These numbers are multiplied together to obtain a 32 bit number in DX:AX representing the actual number of free bytes. In order to return a single-precision floating point number, the SHIFT routine repeatedly does a 32 bit left shift of DX:AX until a bit that is set to a 1 falls off the end of DX and counts the number of shifts required. The routine then calculates an exponent in base two according to the conventions required by BASIC.

The last step is to put the result back in memory where BASIC can find it. This is done by extracting the address of the second argument, used in the call statement FSPACE, from the stack and using it as a pointer to store the result. The original BP register is restored, and the routine does a FAR return with a RET 4; this is necessary to discard the argument addresses originally placed on the stack.

Burks A. Smith is president of Datasmith, Inc., a consulting and programming firm located in Shawnee Mission, Kansas.

LISTING 1: FSPACE.BAS

```
10 ' *** FSPACE.BAS ***   9-1-86
20 ' Determine free space on on path pth$
30 '
40 'Written by Burks A. Smith
50 '            Datasmith, Inc.
60 '            Box 8036
70 '            Shawnee Mission KS 66208
80 '
90 '
100 ' < This is a test program
110 '
120 GOSUB 500 'initialize
130 PTH$ = ""
140 GOSUB 1000
150 PRINT FSPACE;" bytes free"
160 END
170 '
500 ' < Initialize Free Space Subroutine
510 '
520 DEF SEG
530 A=PEEK(&H2E)+256*PEEK(&H2F): CMPL%=NOT(A=530) 'compare A = this line
540 RESTORE 610: FS$=""
550 READ A$
560 WHILE A$<>"/*": FS$=FS$+CHR$(VAL(A$)): READ A$: WEND
570 RETURN
600 ' 8086 instructions for DOS call to get disk free space
610 DATA &H55,&H8B,&HEC,&HB4,&H30,&HCD,&H21,&H3C,0,&H75,&H9,&HB8,0
620 DATA &H80,&H33,&HD2,&H8A,&HCC,&HEB,&H26,&H8B,&H76,&H8,&H8B,&H14
630 DATA &HB4,&H36,&HCD,&H21,&HF7,&HE1,&HF7,&HE3,&H33,&HC9,&H50,&H0B
640 DATA &HC2,&H58,&H74,&H11,&H92,&HFE,&HC5,&HD1,&HE2,&HD1,&HD0,&H73
650 DATA &HF8,&HB1,&HA1,&H2A,&HCD,&HD1,&HE8,&HD1,&HDA,&H8B,&H7E,&H6
660 DATA &H88,&H35,&H47,&HAB,&H88,&H0D,&H5D,&HCA,&H4,0,/*
670 '
1000 ' < Find Disk Free Space
1010 ' expects pth$=path;  returns dr%=drive #, fspace=free space
1020 DEF SEG
1030 IF CMPL% THEN SPO=2 ELSE SPO=1
1040 FS=PEEK(VARPTR(FS$)+SPO)+256*PEEK(VARPTR(FS$)+SPO+1) 'addr of FS$
1050 IF FS>32767 THEN FS%=FS-65536! ELSE FS%=FS
1060 X%=INSTR(PTH$,":"): IF X%<2 THEN DR%=0: GOTO 1080
1070 DR%=(ASC(MID$(PTH$,X%-1,1)) AND &HDF)-64
1080 FSPACE=0
1090 IF NOT CMPL% THEN CALL FS(DR%,FSPACE): RETURN  '<- interpreted
1100 CALL ABSOLUTE (DR%,FSPACE,FS%)                 '<- compiled
1110 RETURN
```

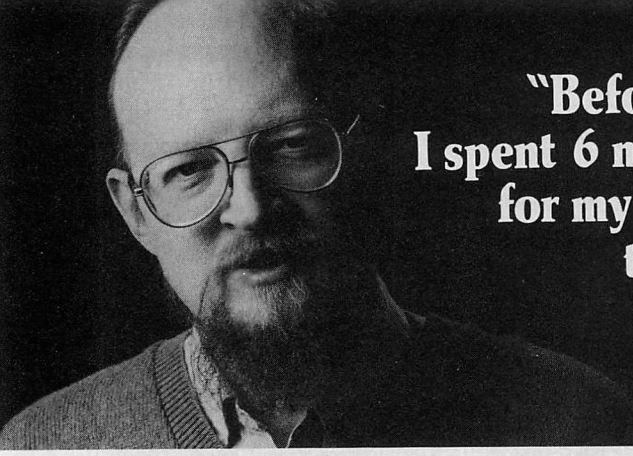
LISTING 2: FSPACE.ASM

```
;               TITLE DISK FREE SPACE SUBROUTINE
;               COMMENT *       5-26-85
;               Basic subroutine to determine free space left on disk.
;               CALLING SYNTAX:

;                       CALL XX(DRIVE%,SPACE)

;               where: XX=the address of the subroutine
;               DRIVE% = An integer variable designating the disk drive.
;                        0=default, 1=a:, 2=b:, etc.
;               SPACE  = A single-precision variable to get the result.

;               Written by Burks A. Smith
;                          Datasmith, In.
;                          Box 8036
;                          Shawnee Mission KS   66208
;               *
;
cseg            segment                 ;run in Basic's data seg
                assume  cs:cseg, ds:cseg
                org     100h            ;for testing.
space           proc    far
                push    bp              ;save base
                mov     bp,sp           ;point at stack
                mov     ah,30h          ;test version
                int     21h
                cmp     al,0            ;is it 1.x?
                jnz     okver           ;jump if not
                mov     ax,8000h        ;force floating point =1
                xor     dx,dx           ;least significant bits
                mov     cl,ah           ;exponent is 80h  (128)
                jmp     short done      ;version 1 exit
;       version 2.0 or later, test free space
okver:          mov     si,[bp]+8       ;get drive # address
                mov     dx,[si]         ;set drive id
                mov     ah,36h          ;free space command
                int     21h
                mul     cx              ;bytes/sec*sec/cluster
                mul     bx              ;avail clusters*bytes/cluster
                xor     cx,cx           ;init shift count = 0
                push    ax              ;save while comparing
                or      ax,dx           ;space left zero?
                pop     ax              ;restore original value
                jz      done            ;jump if so
;       normalize floating point
                xchg    ax,dx           ;format change DX:AX->AX:DX
shift:          inc     ch              ;count the shift
                shl     dx,1            ;shift lsw left
                rcl     ax,1            ;shift msw & pick up carry
                jnc     shift           ;loop if it was a zero
;       32 bits normalized.  fix exponent & mantissa.
                mov     cl,128+32+1     ;bias+max shift+assumed bi
                sub     cl,ch           ;less actual shifts=exponei
                shr     ax,1            ;shift mantissa for + sign
                rcr     dx,1            ;pick up bit & shift lsw
;       store result
done:           mov     di,[bp]+6       ;get addr of result
                mov     [di],dh         ;least significant byte
                inc     di
                stosw                   ;most significant word
                mov     [di],cl         ;and finally exponent
                pop     bp              ;restore bp
                ret     4               ;normal return
space           endp
cseg            ends
;
                end     space
```



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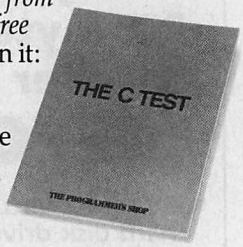

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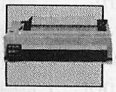

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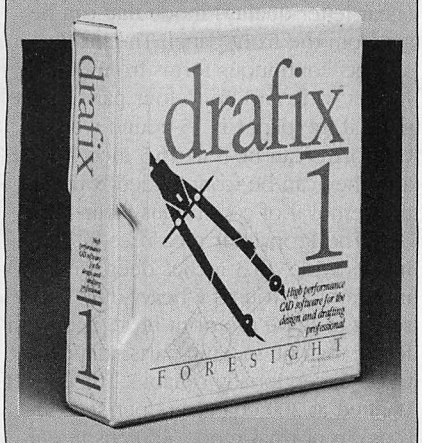

CIRCLE 353 ON READER SERVICE CARD

Drafix 1, a CAD package published by Foresight Resources Corporation, is aimed at the low-end CAD user. Priced at $295, it is among the least expensive products of its type. For an additional $100, Foresight includes a mouse, and for a total price of $585, a Summasketch digitizer pad is included.

Drafix 1 runs on the IBM PC, PC/XT, PC/AT and compatibles. The program requires 512KB RAM, but 640KB is recommended. A drawing is stored completely in memory until explicitly saved. The program uses a math co-processor if one is present. The program supports six types of mice, four small digitizers, and four brands of plotters—Hewlett-Packard (HP), Roland-DG, Houston Instrument (HI), and Calcomp (1043 and 1044 only). Twelve graphics printers are supported, including several color printers and the HP LaserJet.

Support of printers and plotters is limited with drafix 1. The standard configuration of the program supports only plot size C and smaller. Large format (sizes D and E) plotter support is available as an option. For this review, an HI DMP-52MP plotter was used. The large plotter format option was furnished; however, the documentation did not cover cabling or configuration of the DMP-52MP, or any of the large plotters mentioned in the manual. Connection of the plotter with a Smart Cable from IQ Technologies, Inc.—which normally is a very dependable solution—failed to establish communications between the plotter and drafix 1.

The display screen can be printed on a graphics printer, but the facility is limited. Only the portion of the drawing currently displayed can be printed, and the print-out is not to scale. The Print menu includes a set-up function, but it is inactive in the current version of the program. At the present time, drafix 1 printer plots are useful only for sketches and cursory check plots.

The computer must have two serial ports to connect a plotter. Drafix 1 uses one serial port for the pointing device, which must be connected in order to issue commands. A second one is required for the plotter. Printers can be connected to a parallel port or to the second serial port.

Drafix 1 drawings are restricted in resolution by the limited precision of the drawing database. The program stores coordinates, distances, angles, and numbers with an accuracy of 6 to 7 decimal digits, as compared to the 14- to 16-decimal-digit precision of larger CAD programs. The physical size of the program's drawing world, however, has virtually no boundaries.

The drawing database provides for 256 numbered layers, which are organized into 16 ranges. Layers are used to organize the drawing and control visibility, not to assign attributes. A layer can contain items of various line types and pen numbers (colors).

The drawing primitives include point markers (23 symbols), lines, arcs, circles, notes (text, with 12 fonts available), and polyline shapes (boxes, polygons, ellipses, and arbitrary paths). The database structure also provides for symbols consisting of drawing primitives and/or other symbols, and patterns for cross-hatching. Dimensions are not separate primitives, but are stored as lines, text, and point markers.

Entirely menu-driven, drafix 1 makes wide use of roll-down menus. Function menu bars are displayed across the top of the screen, and mode menu windows are displayed along the left side. The bottom of the screen houses a message and text window.

The program was designed for use with a three-button mouse. When the program is waiting for a function to be selected, the mouse moves a Macintosh-like pointer; the left mouse button is the pick button. Selecting a function highlights it on the menu bar and displays the appropriate submenu bar. Selecting a function from the submenu causes the program to prompt for data or to display another submenu, depending upon the function. The path to the current function is indicated by highlighted menu items.

Coordinate data can be entered in absolute, relative, and polar form from the keyboard. Using the pointing device, data points can be snapped to gridpoints; to the endpoint, midpoint, or nearest point of a line or arc; to the intersection of two lines or arcs, and to the center of an arc or circle, and the nearest point of a line or arc. The current mode of input is indicated by, and selected from, the coordinate input mode menu or from the keyboard. The coordinate input mode can be changed while a function is in progress, but not always from the menu—keyboard mode selection is required in some cases.

Drafix 1 includes a full assortment of display controls, including zoom,

pan, reset (to the full drawing sheet), and stored views. These functions are not available when other functions are active—that is, display control functions cannot be nested within other functions. The display control menu includes a **full** selection, which fills the entire screen with the contents of the drawing window, eliminating all of the menus and other windows.

Drawing aids include a two-level grid, object snap modes, automatic dimensioning, hatching, angle locks (for drawing lines that are horizontal, vertical, and normal to the last line), and continuous coordinate read-out in any one of four formats: absolute and relative *X* and *Y* coordinates and absolute and relative polar coordinates.

In operation, drafix 1 is fast. The cursors move smoothly even when the pointing device is moved rapidly. The roll-down menus appear in a split-second, and screen redraws require only a few seconds. Drawing operations are also fast. The program is written in C and is based on the Halo graphics library from Media Cybernetics, which may account for the speed and smoothness of the program's operation.

Much of the speed of this package is a result of the active drawing residing entirely in RAM. This has some disadvantages. The drawing is limited in size to 227KB in a PC running DOS 3.0 with several device drivers and resident programs loaded. In addition, no temporary file is available to recover in the event of a system crash or power outage. This limitation, however, does not preclude using the program in a production environment for small- to medium-sized drawings.

One point that new users will appreciate is the way in which drafix 1 addresses scale. It operates in the traditional manner of drawing to a scale—the operator selects the sheet size from a menu and then sets the scale, before beginning to draw. This method does not prevent drawing outside the area set up as the maximum sheet size or changing the sheet size.

Drafix 1 lacks some of the features found in larger and more expensive CAD programs, but it is well suited to basic drafting tasks on a low budget. New CAD users will find drafix 1 much easier to learn than some of the more comprehensive programs. Plotter and printer support could be improved, but the screen handling and general operation are excellent.

—VICTOR E. WRIGHT

IBM PROPRINTER XL

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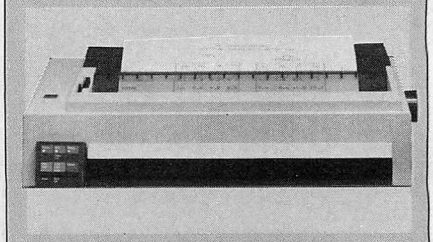

CIRCLE 352 ON READER SERVICE CARD

IBM has a winner in the Proprinter XL. This American-built, wide-carriage, fast dot-matrix printer has an NLQ (near-letter-quality) mode that can be set from the front panel. The printer accepts continuous forms from 3 to 15 inches wide and up to four parts (three parts if the paper is 15-pound weight). Cut forms can be 3 to 16.5 inches wide, and they can be front-loaded without the removal of continuous forms.

The Proprinter measures 22.6 inches wide, 14.3 inches deep, and 5.25 inches high. It uses a heavy-duty lead screw to drive the print head, and, with fewer than 60 moving parts, it appears to be exceptionally reliable. The printer is rated at 200 characters per second (cps) in normal mode, 100 cps in emphasized mode, and 40 cps in NLQ mode. The printer feeds paper at three inches per second. These are peak figures and actual rates depend on the nature of a particular job.

The Proprinter XL and Proprinter are replacements for the original dot-matrix IBM Graphics Printer supplied by Epson. The XL appears to be highly compatible with the earlier printer; for example, it accepts, but ignores, the Esc-8 and Esc-9 (ignore paper end) codes, which no longer are required to print cut forms. Unlike the earlier Epson printers, changing paper is effortless. The graphics modes on the Proprinter models display their Epson heritage: the user chooses the Epson printer driver to print graphics from Media Cybernetics' Dr. Halo program.

The manual is excellent. In addition to the guide to operations, a programming guide provides examples for entering escape sequences from the DOS command line as well as from BASIC programs. Along with the refer-

Breaking the 640K DOS Barrier:

New version of Alsys PC AT Ada* compiler improves speed, adds application developer's guide, brings seven 80286 machines to latest validation status.

Alsys' landmark Ada compiler for the PC AT, the first to bring Ada to popular-priced microcomputers, has been upgraded to Version 1.2 with significant improvements.

The new version compiles faster than its predecessor, is validated for a full range of popular compatibles using the latest AJPO test suite 1.7, and includes a Developer's Guide in the documentation set. The price remains at $2,995 for single units, including a 4 megabyte RAM board.

Both the original and the newly upgraded versions utilize the inherent capabilities of the 80286 chip and "virtual mode" to eliminate the 640K limitations of DOS. These techniques permit addressing up to 16 MB of memory, under the control of DOS, without changes to DOS in any way!

80286 machines validated in the new release include HP's Vectra, Compaq's Deskpro 286, Sperry's PC/IT, Zenith's 200 series (including the Z-248), Tandy's 3000 HD, the Goupil/40, and the IBM PC AT. The compiler supports DOS 3.0 or higher. Ada programs compiled on the AT will also run on PCs and XTs supporting DOS 2.1 or higher.

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CIRCLE NO. 141 ON READER SERVICE CARD

Ada now

ence card, a reference sheet shows how to set the NLQ mode on 19 popular software packages. Installation is simple.

Offering a variety of print types formed from combinations of condensed, double-high, double-wide, emphasized, normal, NLQ, proportional, subscript, and superscript modes, the Proprinter XL accommodates print lines of 5, 6, 8.55, 10, 12, and 17.1 characters per second (cps). Nine of the print modes can be set from the front panel. Depending on the mode, the XL can print as many as 232 characters on one 13.6-inch line. The printer supports the PC's full 256 character set and as many as 256 user-definable characters.

IBM has built additional features into the XL. The XL user can set print modes from the front panel, print in a "quiet" mode, adjust cut forms with a movable left paper guide, load a full 256 user-defined character set and use a hexadecimal dump mode to debug complex escape sequences. Even users who do not need the wide carriage offered by the XL model may want to spend the extra $150 for that machine.

Although the Proprinter's boxy NLQ characters may look more like they came from a computer than a typewriter, the NLQ mode does deliver correspondence quality while retaining the regular dot-matrix features of speed and graphics. The cut-sheet feed, faster speed, ease of use, competitive price, and the IBM label add up to make the Proprinter XL an excellent choice.

—JOHN MYRNA

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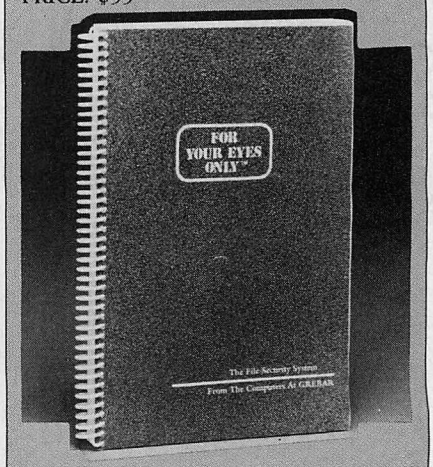

CIRCLE 354 ON READER SERVICE CARD

Even cautious users can become hostage to their own security system when passwords are lost or inaccessible. The file security program For Your Eyes Only (FYEO), published by GREBAR, solves this problem with its two-level privilege system. The two levels are the *corporate security level* (CSL) and the *maximum security level* (MSL). Each time the program is called up, a lower-level user accesses the program by entering a unique CSL access code known only to that user.

The files are assigned with passwords that are usually different from the access code. The encrypted files are then secure, but the top manager can use the program at any time by entering the MSL access code. This higher level allows the manager to override the encryption done at the lower CSL without a knowledge of the passwords used. A new CSL access code also can be assigned by the top manager. In this way, particular users can be denied access to the entire system or allowed ac-

cess, even if their access code is forgotten. For files that are encrypted in the MSL mode, passwords cannot be overridden; in this mode, lost passwords mean lost files.

FYEO is well written, not copy-protected, and runs on an IBM PC or most compatibles with at least 256KB of RAM and one floppy-disk drive. It has a smooth menu-driven user interface, broad functionality, quick response, excellent documentation, and an attractive price ($55). The low price includes two other programs: File Dump, which gives a hexadecimal and ASCII dump of any file, and Convert, which transforms files into hexadecimal code for transmission to any computer system.

Encrypted files are hidden (not visible through the DOS DIR command) and the original unencrypted version is written over so it cannot be unerased. With FYEO, files can be hidden or unhidden, read-only (for users with DOS 3.0 or later), deleted, and exorcised (made inaccessible to unerasing). An entire directory can be exorcised. Users also can process groups of files with what are misleadingly named batch files. These are actually lists of file names, including wild-card specifications, for processing a group of files. However, if 179KB of unused memory is available, FYEO can be made memory resident and can be called up with a single user-specified key at any time. In this mode, users must give an access code each time in order to use the program. The File Dump and Convert programs can be made memory resident.

The encryption algorithm is proprietary, so the level of security cannot be judged accurately, whether at the CSL, where passwords can be overridden, or at the MSL, where they cannot. Passwords can be very long and files can be multiply encrypted at the MSL. On the other hand, claims of superiority of FYEO's encryption over the Data Encryption Standard (DES) are misleading because they are based solely on the length of passwords—a criteria relevant only when using primitive, exhaustive attack techniques. Without careful study of the algorithm, the security of the system cannot be assessed.

A determined attacker could disassemble the program and find out how to get into the MSL mode. The program serial number is coded into all the CSL encrypted files and serves as the identification that allows the MSL to override the passwords. The MSL can override only those CSL files made with the program's own serial number.

A final complaint about the product concerns the use of the cursor pad. The user must engage the NumLock key because selections in one part of the program are actually made with numbers and not the extended ASCII codes for the cursor control keys. Invariably, users exit the program and use the cursor control keys in another program only to find numbers being generated.

Aside from these few minor irritations, FYEO's two-level security modes offer a clever solution to small office security. It puts control of security in the manager's hands and helps with the often frustrating problem of lost passwords. Some of the most attractive features, and perhaps the encryption algorithm itself, could be overcome by a serious attacker, so for demanding security needs, users are still advised to use the DES. Nevertheless, FYEO has a fine price-performance ratio and is useful in organizing office security.

—VICTOR MANSFIELD

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Computer Attitudes

The most important feature of any system is its attitude toward the user.

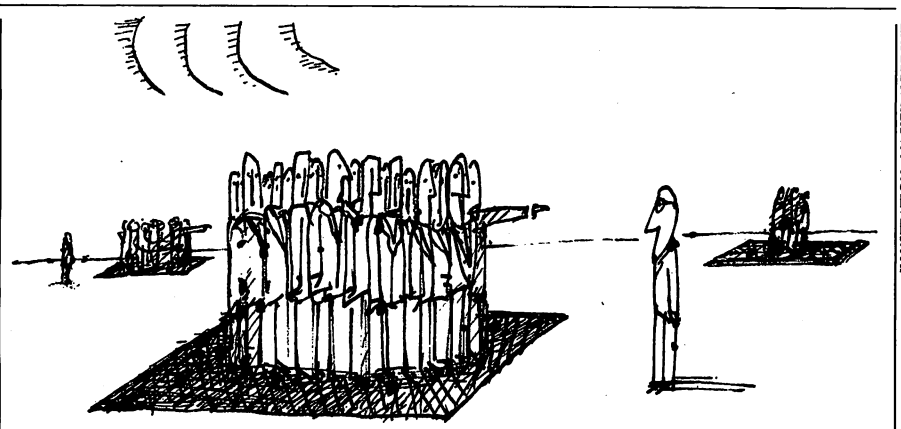


ILLUSTRATION • MACIEK ALBRECHT

Two years ago, my friend Charlie, a freelance writer, bought a small computer and a letter-quality printer. The package included four elements: a filer program, a calc spreadsheet system, a programming method (BASIC), and a word processing program. On the scale of programming expertise, Charlie was an amateur. This is what happened.

Sent home with a battery of user manuals, he began learning word processing. One of the manuals was a collection of engineering documents compiled in no particular order. As one who fancies the use of language to communicate rather than impress, Charlie was unable to gather any intelligence from that manual. He came close to tears trying to interpret the last chapter, "Dynamic Debugging Tool."

Charlie had no idea why one key was used with another to do a task. At first, he needed a little guide beside him to remind him to press Ctrl-S, Ctrl-C, or Esc-Q at the right time. When Charlie decided to use the filer program, he discovered that keys for certain filing functions were different from those for the same situation in the word processing program. When he tried the calc program, he had to learn yet another set of command keys.

Using his word processor, Charlie completed a research project nine months after he purchased the computer. He confidently said that, with the aid of an independently written user manual that he bought off the shelf of a local bookstore, he finally was ready to give his typewriter away to his kids.

What is Charlie's trying experience all about? Human factors. It is about the eyebrow-lifting declarations of computer companies advertising that their computers are "user-friendly!"

In the discipline of computer science, a distinction must be made between the foundational approach that is necessarily quantitative and a qualitative aspect that is seldom considered by programmers. This aspect is variously called human factors, human engineering, or man-machine interface.

No designer would try to create a system that was not user-friendly. Then, why is user-friendliness an issue? The answer is that human factors, as a discipline, has emerged from neglect. Only because the user has received short shrift in the design of computer systems has there been a need to resurrect the user as an issue.

With the exception of a few notable commercial products (for example, the simple, clean design of Macintosh Pascal), the computer industry has lost touch with the deepest human engineering problems in software: a maze of conventions; lack of technical elegance; complexity of individual keystrokes; menu confusion; third-rate documentation; obscure, system-based messages; intolerance to error; special key syndrome; and cluttered screens.

HUMAN FACTORS DEFINED

Human factors has been given many different meanings:

- *Human factors is the study of the needs and capabilities of the human user.* This definition is true. Users do have needs, and they do have limits on their capabilities. The design of computer systems should recognize these limits; but, more often than not, the needs and limits of users are hard to determine. Users are able to adapt to complex systems such as DOS and UNIX (although I would hardly consider these systems as embodying the best in human factors).

Another definition of human factors goes like this:

- *Human factors is the study of the interface between man and machine.* This definition is also true. Human factors concerns more what users see than what they do not see. The underlying operating system may be of no consequence to the user, but the prompts and menus certainly are.

The definition that has helped me most in understanding human factors is:

- *Human factors is an attitude that places the user first.* Admittedly, this definition is rather broad. It encompasses the initial conception of a system's functionality to the determination of the wording of the last error message. What is significant about this definition is the word *attitude.*

The *system* attitude is one that concerns itself with power, speed, and features. The *human factors* attitude may touch upon these same issues, but from a different point of view. Computing power and speed are of interest only if the user can understand and use them.

Whether the user will actually need a system's features is open to debate. Most personal computers are amazingly complex; users often forget how much of a personal investment they put into learning the baroque conventions of today's systems.

The Apple Macintosh has good human factors because of its attitude. While we certainly can question the Macintosh on grounds of power and speed, it is hard to fault its attitude—it attempts to put the user first.

QUALITATIVE QUESTIONS

Several qualitative questions need to be addressed concerning human factors.

How important is the field of human factors? This question has two answers. The first one is: *not at all.*

A large class of users exists that has little conception of human factors—for example, systems programmers and regular users of some of the more complex computer systems. For these users, automation is interesting in and of itself. The maze of conventions and the hundreds of options, each individually interesting, are therefore challenging. Such users are not intimidated by the complexity and impoliteness of the systems. They learn to tolerate the systems and circumvent most of their problems. They thrive on the systems, they do useful work, and they enjoy that work.

C programmers, for example, generally demonstrate a high tolerance for complex systems. Would ease of use really affect the marketing of a C compiler? It is not at all clear that it would. Perhaps, the vendors of such systems should not even pretend to talk about its user-friendliness.

The other answer to the question of the importance of human factors is: *vitally important.*

Consider the following menu, which might appear as part of a subsystem to deal with files.

SAVE FILE
SAVE FOLDER
SAVE AS
COPY
FORMAT
NEW
RENAME
LIST OPTIONS
MANUAL

This menu includes two verb phrases, then an incomplete phrase, then a verb, then a word that could be a noun or a verb, and an adjective all by itself. Hmmm.

At various times, not all options are valid. If the user has just entered the system, does it make sense to save a file? To look at an existing file to do further work, should he select COPY or NEW? Apparently, LIST OPTIONS describes further options the user can choose before proceeding. But why list the options if the user can get them by selecting the correct choice anyway?

There is reason to believe that more choices are available than are listed. How does the user return to the main menu? Can a direct transfer be made? What if he chooses the wrong menu option and is greeted with a question that is irrelevant to the task? This is a common circumstance in all but the simplest menu systems. In a forest of choices, is the user confined to a tree-like structure, or can he jump from branch to branch? How does he get out of the forest when he is stuck?

Someone learning or using this menu will probably be confronted with hundreds of small irritations. There will be an ambient level of stress. Thus, if human factors are viewed as affecting

every moment of interaction between the user and the computing system, then they are, indeed, vitally important.

Who should know about human factors? The quick answer to this question might be that users need to understand human factors. This may be too quick an answer, however.

A user asked to discuss human factors will make remarks such as:

Well, I think my system is good, but the messages could be a bit clearer.

I think there should be a better help facility available.

There ought to be a better way of handling footnotes.

Some of the function names are just not clear.

Users are more likely to list the symptoms of the problems rather than the set of underlying issues. The simple fact is that very few users have ever had experience with a system having excellent human factors. Because they have not seen examples, better methods are hard for them to imagine.

This does not mean that users would not recognize excellent human factors when they appear. Given experience with competing systems, users would notice immediately which, if any, had better human factors.

It is not clear that software engineers understand human factors either. This group uses complex systems and becomes accustomed to them. Their vision, like users', is partly impaired.

Psychologists have much to tell us about the effects of automation on people. They have a different view from both the user and software engineer. They look at stress levels, learning difficulties, and models of user behavior. However, the inspiration for better systems will not come from psychologists. They can help tell us when we have arrived, but not which direction to go.

The correct answer to the question "Who should know about human factors?" is: *designers*. Devising beautiful systems is not a simple task. These challenges are best left to the designers of the systems themselves. The problem of human factors is largely technical as well as cosmetic. The designers are the ones who create systems, and they are the ones who are capable of taking them in the right direction.

How important are low-level interface issues? Low-level interface issues usually bring to mind screen layout, prompts, and system messages. These are considered *low-level* because other issues, such as the choice of menus versus commands or screen size, seem more important.

The argument here is one of frequency. The prompting character on certain popular systems is the letter naming a device drive followed by a greater than symbol (A>). I consider this an obtrusive prompt, yet it has been viewed and printed countless times. This is hardly a passing detail. Even a single character can have a big impact simply because it occurs repetitively in every session with the user.

In summary, what is the definition of human factors? An attitude. How important is the field of human factors? Not very important for some systems; extremely important for others. Who should know about human factors? System designers. How important are low-level interface issues? Very important, by virtue of frequency.

Henry F. Ledgard runs his own consulting firm, Human Factors Limited, specializing in research on the human engineering aspects of computer and software design. He holds a Ph.D. from MIT.

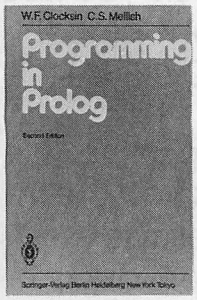
CIRCLE NO. 187 ON READER SERVICE CARD

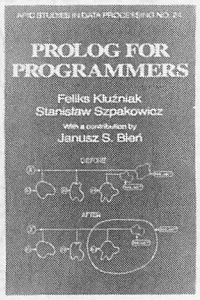
CIRCLE READER SERVICE NO. 209 FOR IBM, NO. 208 FOR APPLE

CIRCLE READER SERVICE NO. 147 FOR "C COMPILER, NO. 154 FOR CROSS ASSEMBLERS

A Prolog Pair

Clocksin and Mellish set a standard for Prolog, while Kluzniak and Szapakowicz offer a study of techniques and optimization for advanced Prolog programmers.





Programming in Prolog
W. F. Clocksin and C. S. Mellish (Springer-Verlag; Berlin, West Germany; 1984) 297 pages, $17.95 paper

Prolog for Programmers
Feliks Kluzniak and Stanislaw Szapakowicz (Academic Press; London; 1985) 400 pages, $47.50

Programming in Prolog, one of the earliest works available on the logic programming language Prolog, established a minimal standard or *core* for Prolog syntax (often referred to as Edinburgh Prolog). It provides a clear, systematic explanation of the essential features of the language together with helpful examples and exercises.

The book begins with a simple description of the *facts* and *rules* that comprise a Prolog program, then proceeds with a more detailed presentation of basic Prolog syntax. It explains how to construct facts and rules about complex data types such as trees and lists. The authors then look at the route Prolog takes through this construction to find solutions to a query. This is probably the most difficult part of Prolog programming to understand, and Clocksin and Mellish provide a reasonably clear discussion of the underlying concepts and many helpful examples.

A chapter on I/O is followed by one on built-in facilities. Especially useful are features that allow a Prolog program to examine and alter itself as it runs. These features, discussed in detail, are important for automated reasoning, natural language processing, and other applications in artificial intelligence. The remaining chapters are devoted to sample programs, debugging facilities and techniques, writing grammar rules for parsing natural language sentences, and the relation of Prolog to logic.

Programming in Prolog has a helpful appendix that discusses different versions of Prolog, including micro-Prolog. This makes the book helpful to programmers using one of the less familiar Prolog dialects, such as the LISP-like syntax used in micro-Prolog. (See "Prolog Arrives," Michael Covington and Andre Vellino, this issue, p. 52, for a review of three Prolog compilers.)

Clocksin and Mellish do not provide material on many advanced topics in Prolog programming; however, anyone seriously interested in Prolog should own *Programming in Prolog*. Moreover, this classic text prepares the programmer for several new books on advanced Prolog, one of which is *Prolog for Programmers*.

This book by Kluzniak and Szapakowicz contains a wealth of practical information about how to use Prolog. It also includes the Pascal source code for a complete Prolog interpreter. The authors use a Prolog implementation developed at their laboratory in Poland. It consists of an interpreter for a subset of Prolog (called Toy Prolog) plus a set of extensions written in Toy Prolog that makes it highly compatible with the Prolog used by Clocksin and Mellish. Source listings for the interpreter and some software tools are provided in appendixes in each text.

The first chapter, "Introduction to Prolog," discusses data types, unification, and backtracking, all on a rather abstract level. The unification algorithm is described in Pascal-like pseudocode to show exactly how it works.

The authors clear up several points that other manuals leave unclear, for example, what happens when a cut is executed inside a variable call. (It behaves, they point out, exactly as if it had occurred in the clause containing the variable call.)

The second chapter presents a brief but exceptionally lucid treatment of the relationship between Prolog and formal logic. Chapter 3 deals with definite clause grammars (here called *metamorphosis grammars*); it also addresses the important question of how to avoid endless loops. The examples are taken mostly from symbolic rather than from natural languages.

The heart of the book is found in "Simple Programming Techniques"; the book is worth buying for this chapter alone. All of the examples are original and less than obvious solutions to important problems. The first example deals with creation and traversal of binary search trees; the result is a highly efficient sorting algorithm that takes just a few lines of Prolog.

Other gems include a one-line map-coloring program, the use of trees as a substitute for arrays, and an implementation of the Quicksort algorithm.

Additional chapters include the manual for the authors' version of Prolog, listing all of the built-in functions; a discussion of general implementation issues, especially structure sharing and the use of data structures; and a description of the workings of the Toy Prolog interpreter itself. Chapter 8, contributed by Janusz S. Bien, briefly discusses other dialects of Prolog, including Alain Colmerauer's Prolog I and II.

Prolog for Programmers is highly recommended for anyone who wants to program in Prolog, with one warning: a basic knowledge of the language is necessary. As a successor, to the Clocksin and Mellish work, this book is addressed to more sophisticated users.

—DONALD NUTE
MICHAEL COVINGTON

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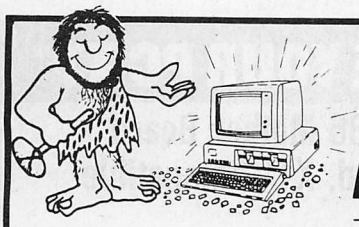

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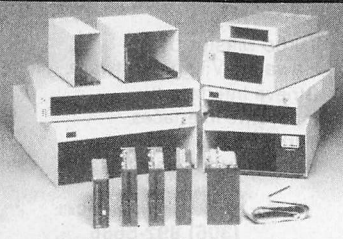

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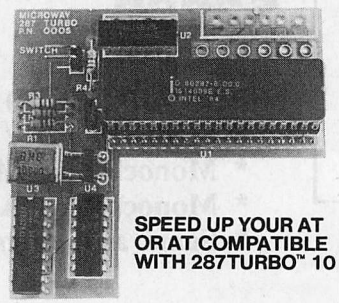

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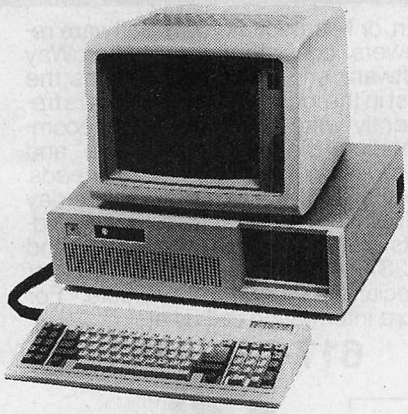

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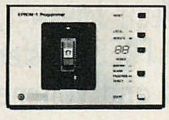

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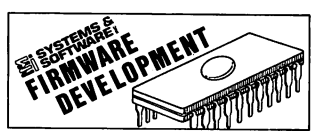

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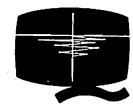

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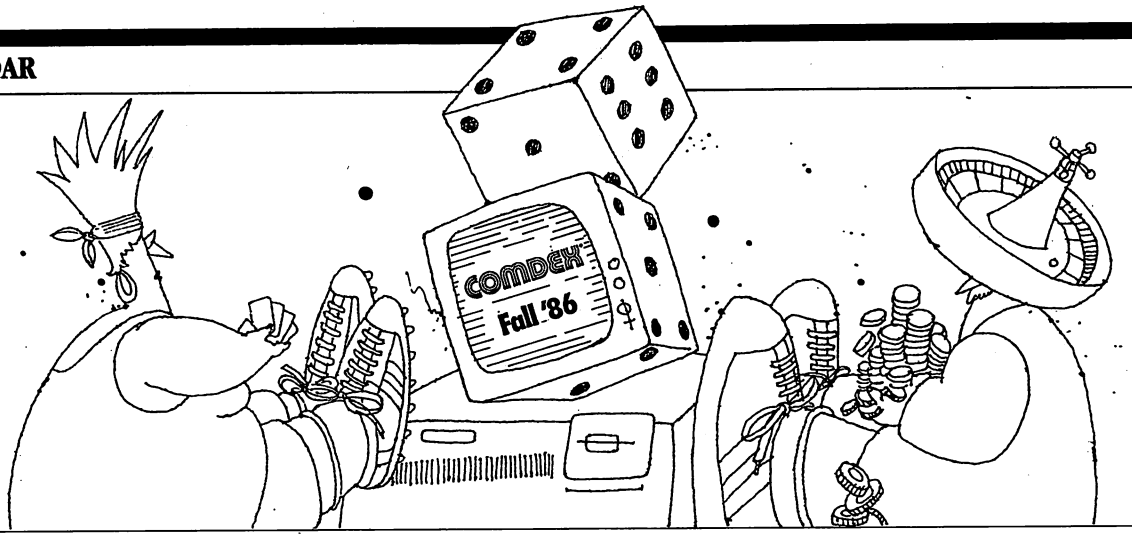

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December 9-11
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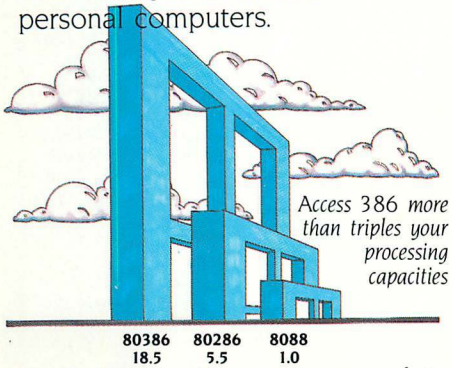

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